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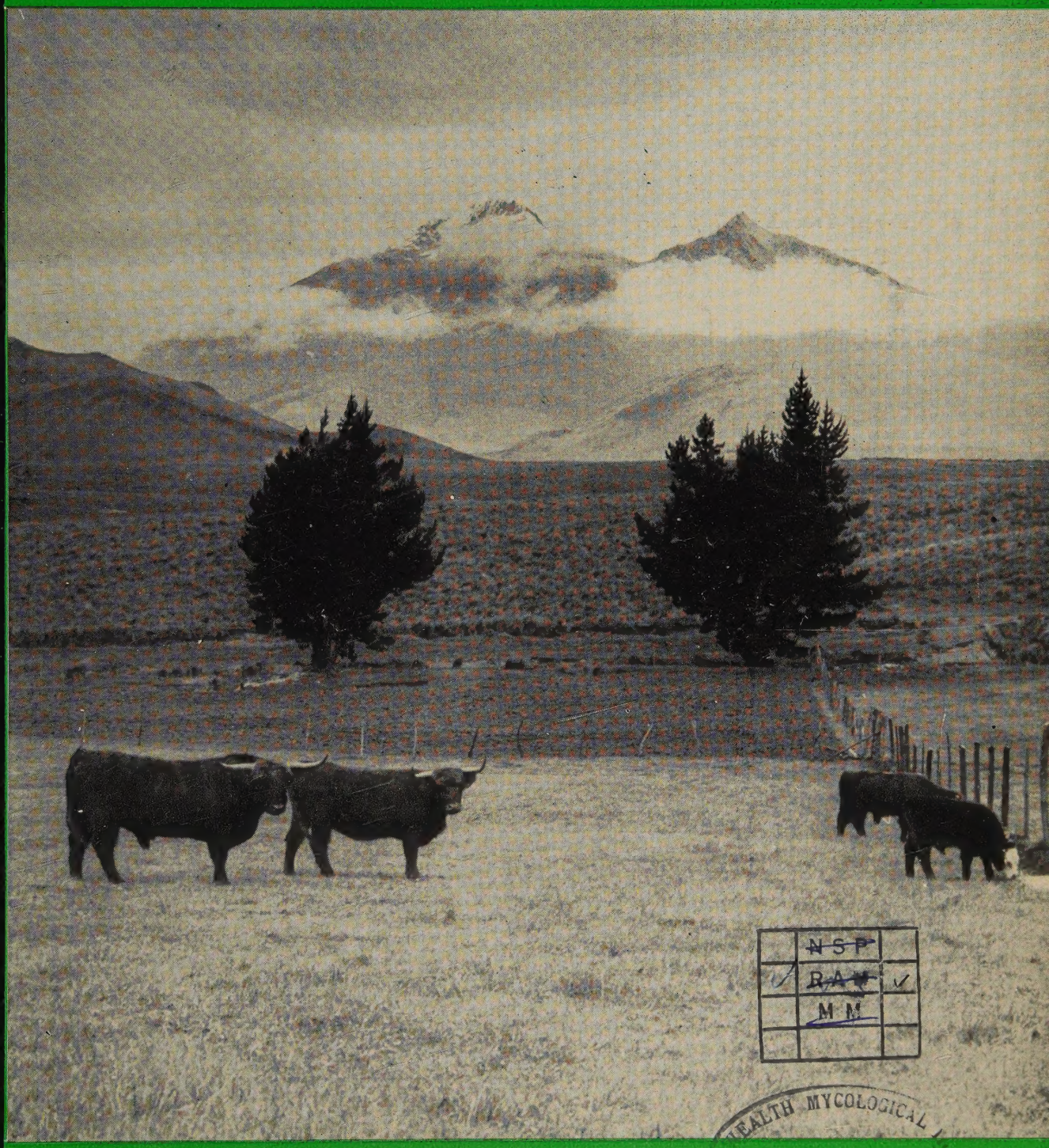
Unasylva

AN INTERNATIONAL REVIEW OF FORESTRY AND FOREST PRODUCTS



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FAO — The Food and Agriculture Organization of the United Nations — grew out of a United Nations Conference held at Hot Springs, Virginia, U.S.A., in May 1943. The nations agreed to work together to secure a lasting peace through freedom from want. The Organization was formally founded at Quebec, Canada, in October 1945. It was located at Washington D.C. until 1951 when the Headquarters office was moved to Rome.

Unasylva is prepared by the Forestry and Forest Products Division, directed by Mr. Egon Glesinger and published every quarter in English, French and Spanish. It attempts to cover a range of interest as wide as that of the Forestry Division whose work it mirrors. Signed articles express the opinions of the authors and do not necessarily represent the views of the Organization. All material in ***Unasylva*** may be freely reprinted, but acknowledgment is requested, together with a copy of the publication containing the reprint.

Cover Photograph. *Vast stretches of unproductive* paramo (*moorland*) *occupy a great portion of the Andes mountains in South America. Afforestation together with sheep and cattle breeding are being attempted. At a high altitude (3,550 meters or 11,700 feet) experimental station at Cotopaxi in Ecuador, FAO has introduced Highland cattle from Scotland with the object of finding a breed of beef animal adaptable to the rigorous conditions. The mountain in the background is Iliniza (5,260 meters or 17,380 feet).*

Courtesy, W.J.V. Taylor

Unasylva

An International Review of Forestry and Forest Products

WORLD SEED CAMPAIGN

TREE-PLANTING programs in many countries are still at the stage of using seed and stock from the most readily available sources, irrespective sometimes of species and generally of quality and origin. As the resulting young forests and plantations grow older it becomes evident that, for the particular soil and climatic conditions, the choice of species or races should have been made more carefully.

Research has shown the importance of geographic sources of seed, emphasized by failures through using seed from outside the country or from other areas within the same country, without regard to the latitude, altitude, temperature, or rainfall of the planting site compared to that from where the seed came.

In a few countries a beginning has been made to identify, within a given geographic source of seed, superior strains and high quality parent trees whose growth rates, technical properties, or outstanding resistance to insect and diseases offer promise of elite progeny. Progress in tree improvement through the efforts of geneticists and tree breeders deserves serious consideration when it comes to formulating tree planting programs. Abundance of supply of seed of the right species at the right time is certainly important. But it is becoming increasingly clear that the forest tree seed used must be of definite geographic origins suitable for the planting sites. And for the future, even more essential will be the procurement of seeds of superior strains from elite quality parent trees to assure those characteristics and growth rates which make the difference between profitable and unprofitable investments, not only in national tree planting programs but in all agricultural, horticultural, and forestry production.

The FAO Conference in the report of its last session, says: " The extensive use of high-quality seed of improved varieties is one of the most generally and most economically applicable measures for increasing productivity." It was decided to launch an international seed campaign and to designate an International Seed Year, probaby in 1961, during which time all Member Governments would initiate or intensify " programs for the production and distribution of high quality seeds through a suitable national authority." All interested international, governmental, and nongovernmental organizations were asked to join in the campaign.

Agencies, organizations, and special interests concerned with forest crops must certainly be represented in such national efforts, in concert with farm and horticultural interests, and foresters are expected to participate actively in national seed campaign committees which will be formed to promote various activities connected with tree improvement; seed production, certification, and distribution; and education. Each country will of course select, in these three types of activities, those kinds of projects which are most appropriate. Needs differ between countries and the degree of forestry development varies from one area to another.

The Director-General of FAO has stressed that the World Seed Campaign is primarily a matter for the individual governments to organize and conduct according to their own ideas, stage of technical progress, and facilities. FAO will assist through advice, suggestions on desirable action, co-operation with appropriate international and national bodies, and preparation of technical and educational material for use in the various countries.

Foresters, the forest tree seed trade, and forest industries have much to gain from the success of this World Seed Campaign.

FIGURE 1. – *View showing a typical privately-owned intermingled forest and agricultural land pattern in the United States. (State of Pennsylvania).*

All photographs by courtesy of the United States Forest Service

FIGURE 2. – *A farmer tightens the binder on a load of sawlogs ready to be hauled to sawmill: he had done his own logging. His neighbor, right, furnished the truck. It is a common practice for neighbors to help each other with timber harvests. (State of Louisiana).*

Improving Small Woodlands in the United States

W. S. Swingler
Assistant Chief, United States Forest Service

In the United States the forestry profession is relatively young. America's first formally trained foresters went to work about 1898. The job of developing the forestry profession and acquainting the American people with forestry has been one of the principal tasks of American foresters ever since.

The attitude of the American woodland owner toward what the forester considers to be good management practice is often conditioned by the owner's knowledge of the principles of forest management and how much good he thinks their application to his woodland would do him. How well he is acquainted with the type of forest assistance that is to be had and how he should go about getting it may also affect his decision.

How repeatedly to carry the forest conservation message to the woodland owner in new and fresh ways presents a continuing challenge to American foresters.

Information and Education

One of the most important approaches to securing better management of the small privately-owned woodlands in the United States is through the informational and educational programs of the national, state and local governments, the forest industries and privately-supported forestry associations. The forest owner must be convinced through information and education that better forest practices are desirable for his land; he must want them.

National action

The Forest Service and the Extension Service of the United States Department of Agriculture conduct many informational and educational activities throughout the country, to get the small woodland owner interested in doing more to improve his woodland. Much of this activity is in co-operation with state and private agencies, including many forestry associations. These activities take various forms. It may be a motion picture on how to plant trees. It could be a television or radio program on how to prevent forest fires. It may consist of any number of bulletins and leaflets on any number of forestry subjects designed for the lay timber owner. And it could be a speech, a slide lecture, a personal contact, or a trip to a forestry demonstration area. All of these and other information media are used every day by American foresters.

Much of this information activity deals with forest fire prevention, which is still a major problem in the United States. During the past decade the Co-operative Forest Fire Prevention Program has helped bring a spectacular drop in the number of man-caused forest fires. This is a co-operative program between the United States Forest Service and 45 individual state forestry departments. It is, in a great measure, financed and supported by American business men as a free public service on behalf of forest conservation. The program is more popularly known as the Smokey Bear Forest Fire Prevention Program after the symbolic bear that has been adopted as the national trademark of forest fire prevention. A new central theme, built around "Smokey," is developed each year. This program is sponsored as a free public service by the Advertising Council, Incorporated, a nonprofit, nonpolitical organization whose members operate privately-owned advertising businesses. Last year, American business men contributed about 10 million dollars worth of magazine, newspaper, and billboard space, television and radio time and other services to the program. Forestry and related agencies, both public and private, as well as hundreds of schools and associations, participate in the Co-operative Forest Fire Prevention Program each year. This program is one of the best single examples of how the national government, the states, forest industries, American business men, civic organizations, and individuals harmoniously work together to accomplish a highly worthwhile public service objective.

Special educational attention is given to those American farmers who own 62 percent of the nation's small woodlands. The extension service of the United States Department of Agriculture is the principal federal educational agency dealing with American farmers. It is a partnership arrangement in which the national, state and county governments sit in council with rural people and together they look at their resources, develop programs for improving land practices, and determine how they should be carried out. The extension service aims at wider participation of farm people in programs which encourage them to improve methods, and do things for themselves. Among the problems confronting many farmers is the development of better timber

stands, better yields, and a better income from forest lands. Owners are assisted with plans for growing and harvesting timber as a crop in connection with the overall management program for the farm. Extension foresters work closely with farm owners, rural youth, state forestry departments, forest industries, banks and other public and private agencies interested in forestry.

State action

The various states employ 90 full-time state extension foresters who work through local county agricultural agents. In addition, 46 out of the 50 states have state forestry departments. These departments are in a large measure locally supported, separate and completely independent from the United States Forest Service which is the national forestry organization. Each of the state forestry departments conducts forestry information and education programs. Some states, such as Florida, not only have a centralized information and education division, but have individual information foresters stationed throughout the forested sections of the state. The individual state organizations are near to the people who own the timberland and therefore in an excellent position to contact them on the behalf of better forestry.

Industrial and forestry association program

The wood-using industries of the United States are aware of the fact that more than half of all the commercial forest land is owned by small forest owners. These privately-owned industries have tremendous investments in plant and equipment. In many cases their chief source of wood supply is the small forest owner. Since America's forest industries provide the principal markets for the small forest owners' timber products, they have a vital interest in them. The forest industries have a number of strong educational forest conservation programs, many of which are conducted in close co-operation with respective state forest services. Among the outstanding industry programs is the Keep America Green Program to prevent forest fires and the Tree Farm Program to give recognition to timber owners who now practice good forestry and are willing to pledge themselves to continue the practice on their lands.

There are numerous other forest industry educational programs, some sponsored by individual forest industries, some by wood-using industrial associations. The Southern Pulpwood Conservation Association is an outstanding example of an educational program designed to bring better management to the small woodlands. Much of the forest industry work is centralized in the American Forest Products Industries, Incorporated, a privately-endowed, nationwide organization of forest industries. The wood-using industries now employ more foresters than the national and local governments combined. The trend is toward more and more information and educational activity among the small woodland owners on behalf of better management practices.

Small Forest Protection

Forest fire protection

The 4.5 million owners of small tracts of timber together have over 265 million acres (about 55 percent) of all commercial forest land in the United States. To

Figure 3. – *High school students (the science class) planting red pine* (Pinus resinosa) *on their school forest land. (State of Wisconsin).*

produce an optimum volume of quality timber these small woodlands must be adequately protected from fire. The level of this protection should assure the private owner the privilege of insuring his woodland at a fair rate.

The protection of these lands, if left entirely to the owners, results in a problem to our forest economy, both federal and state. Many of the owners are interested in activities other than timber growing and wood manufacture. Many are not resident on their forest acres and, in the main, protection of these small acreages from fire by the owners is practically nonexistent. Where the owner tries by himself to provide protection he often finds the expense prohibitive. Sometimes there is a banding of owners into associations for mutual protection which works reasonably well when a large landholder leads the way. But the country cannot rely upon associations of landholders to present an unbreached front to forest fires. More and more the responsibility comes to rest upon organized public protection and, in most states, the pattern decidedly follows that approach.

Organized public protection calls for a responsible agency of the state government, normally the state forester, to furnish the necessary leadership in statewide protection of forest lands. The national government matches this effort with both co-operation and a cash reimbursement in order to stimulate adequate protection of forest resources throughout the nation and to provide a basis for proper management. The program that has developed in forest fire protection during the last 50 years has resulted in an increase of protection coverage from a beginning of 61 million acres to 396 million acres in 1957.

While impressive progress has been made in the protection of both the small and large-sized woodlands in the United States since 1911, much remains to be done. Americans are working to bring organized fire protection to 39 million acres of forest lands which are still unprotected. They are also bending their efforts to bring better protection to 200 million acres of forest land now receiving only a minimum level of organized protection.

Forest pest control

In the United States, annual timber losses due to insects and diseases exceed fire losses. Foresters are working vigorously to plug this drain on forest resources. Insect and fungus pests respect no boundaries.

In recognition of this fact two national pest control laws provide for shared responsibility with state and local governments and private owners in the control of forest insects and disease on all forest lands irrespective of ownership. Under the terms of these laws, the national government will share the cost of suppressing forest insects and diseases on nonnational lands. Leadership, technical direction, detection and biological evaluation of outbreaks are also provided as needs require.

FIGURE 4. – *An American forester comes to the woods to advise a small woodland owner on management of his timber. The owner, states, " When I want to borrow some money, I don't. I go to my woods and cut something that needs to come out anyway. "* (*State of Louisiana*).

State legislation relating to the control of forest insects and diseases is essential to full co-operation. Most states with forest resources have enacted such legislation and also provide financial and technical assistance to all forest landowners, including the small woodland owner. Thus, financing control of forest insects and diseases on small woodlands is, for most situations, a three-way sharing proposition by the national and state governments and the private landowner.

Under the leadership of the national government a detection program is carried out on most of the nation's forested lands to discover destructive outbreaks early. Such outbreaks are evaluated biologically by national and state agencies to determine their destructive potential and need for suppression. National and state research organizations carry on continuous studies and experimentation to develop better and cheaper suppression methods and to make them available to the small woodland owner.

FOREST MANAGEMENT ACTION

State and national

The partnership concept of joint state-federal responsibility for securing better forest management in woodlands of America is a tested concept that has proved particularly successful in the United States. In most co-operative state-national forestry programs there is

cost sharing by the parties involved. As the state organizations build themselves up, they assume a larger share of the responsibility and cost for getting the forestry job done in their states.

Tree planting and reforestation

About 43,700,000 acres of understocked or nonstocked plantable privately-owned, commercial forest lands are in need of planting. Last year, for the first time in its history, the United States planted more than one million acres to trees. It took over one billion trees to do this, 72 percent of which were grown in state-operated nurseries.

The United States Department of Agriculture has been interested in these plantable lands for many years. It has provided assistance to landowners in planting trees for decades. This assistance has been given through co-operation with and financial assistance to state forestry agencies in:

1. production, acquisition, and distribution of trees to landowners at favorable prices, generally much below cost;
2. technical advice on when and what trees to plant and how to plant them.

Through its agricultural conservation program, the Department of Agriculture also provides financial assistance to farmers to help cover the cost of planting trees and site preparation work to encourage the natural reseeding of trees. Under this program, the federal government pays from 50 to 80 percent of the total cost of the trees and the work performed in tree planting and site preparation.

There is tremendous activity in tree planting in the United States. Local banks, forest industries, trade associations, county governments, soil conservation districts, civic clubs, and schools sponsor tree planting on small ownerships through financial, technical, and other forms of assistance. The purchase, operation, and maintenance of tree planting machines is frequently financed and administered co-operatively by such local organizations and agencies. The availability and efficiency of tree planting machines have increased the amount of tree planting to a marked degree.

As a part of a national program to take marginal crop lands out of production, the Soil Bank Conservation Reserve, a special tree planting practice, has now begun to add a substantial acreage of forest plantations to small woodlands. Under this program, the farmer contracts with the government to withhold from agricultural crop production specified areas of crop land and agrees to apply and maintain conservation practices on this land during the contract period. The federal government pays up to 80 percent of the cost of applying the practices and makes a rental payment to the farmer each year of the contract. A total of 3 million acres is expected to be planted to trees under this program by 1962.

The Great Plains in the central United States are subject to periodic droughts and dust storms. The Prairie States Forestry Project was conceived in 1934 to aid farmers in planting shelterbelt-windbreaks of trees to protect fields from the damaging effects of winds. As a condition of planting by the government, co-operating farmers agreed to fence, cultivate, and maintain the tree belts. The project, which was directed by the United States Forest Service during its first eight years, is now administered by the Soil Conservation Service. Both of these services are in the United States Department of Agriculture. The Soil Conservation Service also gives on-the-farm technical assistance to farmers and ranchers in planning, applying, and maintaining conservation farm and ranch systems, including farm woodlands. The conservation plan includes anticipated actions for land use and soil and water management and for conservation and use of cultivated land, grassland and woodland.

Co-operative forest management program

This is a partnership program of the national government and the states to furnish the small private landowner with technical advice on the management of his land for forestry purposes. Under this activity the individual states employ professional " service " or " farm " foresters who meet with the landowner out on his land and give on-the-ground advice and technical assistance as to its management. They will advise on the most profitable type of product, selection of trees for cutting, sales practices, improvement of the remaining stand, and other matters relating to practical, profitable long-range forest management.

If a specific tract's condition permits, this forester will advise the landowner on how to harvest a portion of the crop while at the same time build the remainder to a better, more valuable condition for future growth. If the tract is small so that it can be examined and the advice given in a few days of time, this service is free. Some states charge for marking this timber for sale and, if the tract is large and presents a complex management problem, the state forester will recommend that the owner employ a private consulting forester, who works for a fee.

By the end of 1957, the program over the years had reached a total of 336,000 woodland owners, involving over 30 million acres.

Naval stores conservation program

In the United States, turpentine, rosin and numerous derivatives are made from the oleo-resin of slash pine (*Pinus elliottii*) and longleaf pine (*Pinus palustris*). These pines grow abundantly in the southeastern states, mostly on the properties of small woodland owners.

About 20 years ago, the United States government initiated a program to stabilize the naval stores industry and improve its practices. The woodland application of this program is under the direction of the United

FIGURE 5. – *Many small woodland owners do their own logging and skidding with their farm horses.* (*State of New Hampshire*).

States Forest Service of the Department of Agriculture, and is administered as part of the over-all Agricultural Conservation Program of the United States.

In this work cost-sharing benefits are offered to those timber producers who employ improved naval stores conservation and forestry practices. It has been an important factor in making the turpentine belt of the southeast possibly the outstanding example of well-managed forest properties. The program has gone a long way in changing the naval stores industry from destructive practices of working small trees to a permanent industry with conservative practices. These practices provide a more profitable operation and also save the trees for other uses — lumber, poles and piling, and pulpwood. Fire protection and good cutting practices are basic requirements. Approximately 2,500 producers are directly assisted and another 2,500 are provided with information annually.

Cost-sharing in forestry

The United States Department of Agriculture's Agricultural Conservation Program (ACP), begun in 1936, has helped advance good forestry practices. Through it a landowner can receive cost-sharing financial help to improve his forest management. It is conducted by the Agricultural Conservation Program Service. With variations suited to fit local conditions the program operates by helping the landowner defray the costs of carrying out such good forestry practices as planting trees, thinning crowded stands, pruning young stands, eliminating " weed " trees, and other practices on his land.

To participate in the program the landowner must get in touch with the local agricultural stabilization and conservation committee composed of his neighboring farmers in which the land is located and work out, in advance, a systematic program of forest improvement in accord with locally recommended specifications. Upon completion of this work in a manner complying with these standards of performance, federal assistance is paid. In most localities these cost-share payments amount to about 50 percent of the cost of doing such work.

To date, the Agricultural Conservation Program has helped farmers to plant 2.2 million acres to trees. In addition, timber stand improvement work has been done on 1.6 million acres. The tree planting practice has been voluntarily adopted on over 30,000 farms and the timber stand improvement practice on over 8.5 thousand farms.

Soil conservation: district action

There are over 2,700 soil conservation districts in the United States. These legal subdivisions of the state governments are voluntarily organized by the citizens of a watershed, county, or community. They now cover over 90 percent of the agricultural land of the nation. Through an elected governing body, usually called a Board of District Supervisors and composed of citizens of the district, each district directs and manages its own soil conservation program. Supervisors are interested in the conservation of all natural resources and can call upon all federal and state agencies for assistance in giving technical guidance to all landowners within the districts.

FIGURE 6. – *In flatwoods country of southeastern United States it is often possible to drive a pulpwood hauling truck right to the cut tree. This reduces logging costs and brings the woodland owner a higher profit. Note that pine trees of this small woodland are not only producing pulpwood, but are being worked for naval stores as well. (State of Georgia).*

Community forests

Community forests serve as memorials, meeting grounds, and outdoor laboratories for students, homes for wildlife, and places for recreation. They can be profitable too, if good forestry practices are followed. The size may vary from one acre to 100 acres or more.

The need of the community is the guiding principle in determining the kind of forest to be developed. Locally-owned forests may be as different in character as the 440-acre Escambia County rural youth forest in Florida; the 15-acre community forest planted by the Future Farmers of America youth organization in Lowell, Michigan; the one-acre home demonstration tracts of Arkansas, or the 600-acre community forest at Arcata, California. These forests are designed for the same purpose, namely, to build a unified community spirit by working in friendly co-operation with others to develop something for the benefit of all. Desirable qualities of such forests are:

1. good accessibility;
2. attractive features, both scenic and recreational;
3. high demonstration value, such as timber in various stages and conditions of growth which will permit a continuous balanced operation.

As a public service American foresters render free advice, management plans, and subsequent on-the-ground assistance. Records are essential to the continuation of the original objective under successive leaderships. Usually title to the land is held by the counties, cities, towns, state agencies, schools and organizations.

There are about 4,000 community forests covering a total of about 4½ million acres in 40 states.

Rural development programs

The United States Department of Agriculture and other departments and agencies of the national government have joined with the individual states to make balanced farm, industry, and community development in underdeveloped rural areas a principal objective of national policy. To implement this policy, the rural development program has been started on a pilot or demonstration basis in 63 counties and 9 areas of two or more counties each in 30 states and Puerto Rico. Many underdeveloped rural communities are looking to their own forests and woodlands for greater economic strength.

Forest growth covers a large portion of rural America. Wide areas, even whole regions, depend on their forest resources — wood, water, wildlife, recreation — for use and basic income; for social and economic advancement.

Local industry is often glad to help in production and market promotion, for instance, through increased purchases of wood where steady supplies can be assured. An example of this has been the operations of the Champion Paper & Fiber Company in the State of North Carolina. It employs 2,800 local workers and provides indirect employment for an additional 6,000 families through purchases of pulpwood.

Action to improve watershed conditions on small woodlands

Soil and water are basic resources. In the United States, as in other parts of the world, the top soil is a relatively thin skin of earth covering rock, gravel, clays, sands, and other sub soils. The task of keeping this productive top soil from washing or blowing away and controlling the flow of water is a challenging one in which America's small woodlands play a prominent part. Studies have shown that flood sources are often relatively small areas which need to be stabilized with vegetation. The condition may be the result of forest fires; overgrazing by livestock; or poor farming or timber cutting practices. In most cases, these lands are privately owned. The national government, in co-operation with the states and private landowners, conducts a vigorous program of watershed improvement and flood prevention through soil stabilization. The general responsibility for administering these programs has been delegated to the Soil Conservation Service. The United States Forest Service has responsibility for the forestry phases.

The forestry measures installed under the watershed program are aimed at prevention of damage from soil erosion, flood water, and sedimentation. Recommended improvement measures on a given woodlot may call for better control of cover-destroying forest fires. It may be necessary to fence a critical land area to keep out grazing livestock. Trees may have to be planted on denuded or understocked lands to check erosion. And one of the most productive activities might be that of convincing a timber owner who was about to cut his timber, to do it in accordance with good forest management practices. The cost of these measures is shared by the national government and the state government and private landowners in accordance with cost-sharing principles established by active forestry programs.

About two thirds of one million acres of marketable woodland owned by almost 10,000 owners has already been placed under forest management under watershed program activities.

Action by self-employed consulting foresters

Better forest fire protection, advanced mechanization in logging and milling, a rapid expansion in wood-using industries that use thinnings and other improvement cuttings, new uses for wood at one time considered "weed trees," and better road accessibility are helping to make timber growing a more profitable investment than ever before in the United States. An indication of the interest in forest management in the United States is the fact that today, in addition to the free forestry service performed by public and industry foresters, there are over 350 self-employed consulting foresters who make their services available to timber owners for a fee. This is an increase of almost 900 percent in the number of forestry consultants in the United States in the last 12 years. Most of these consultants have both good professional training and considerable experience in multiple-use forest management and are available to give technical advice and assistance to woodland owners, both large and small.

Timber stand improvement, tree planting, fire, insect and grazing control, taxes, insurance, selective cutting, harvesting, marketing and the wise economic use of the forest resources from their client's property are all activities which the present-day forester, in private practice, is capable of considering in any prescription and complete management plan he may make for a woodland. Complete forest land management involving recreation, water, wildlife and forage is the criteria on which their service to the woodland owner is now predicated. Working under the code of ethics of the Society of American Foresters, provisions of special licensing acts in some states, and the objectives of the Association of Consulting Foresters, the private consulting forester is now an important and necessary part of any improvement program for the small woodlands of America.

Research Action to Improve Small Woodlands

Forest management research

Most forest research in the United States is conducted by the national government supplemented by research by the forest industries, the states, and forestry colleges. Forest management research can help and has helped the small woodland owner in the practice of forestry from seed to sawlog. The owner can derive greater income from his woodlands by growing higher-quality products. Research has shown him how to do this in a great many ways.

One way is to grow a better quality or a faster growing tree. Research in forest genetics and forest tree improvement has demonstrated that better trees are a reality. For example, select southern pines (*Pinus elliottii* and *Pinus palustris*) capable of yielding greater amounts of oleoresin for naval stores have been isolated and certain of these trees have been shown to be genetically superior in pine gum yield. When seed from these superior trees becomes available commercially, the naval stores operator will certainly profit by growing the superior strain.

In the northeastern and midwestern United States, hybrid poplars of outstanding growth rate or desirable figured grain have been developed or isolated. The figured grain hybrid is particularly promising for the small owners of the Midwest. Tree breeders have created many hybrid pines, like the Monterey-Knobcone (*Pinus radiata - Pinus attenuata*) cross, suitable for planting in California woodlands, the shortleaf-loblolly (*Pinus echinata - Pinus taeda*) pine cross, which seems to be resistant to fusiform rust, for planting in the southern United States, and the ponderosa-Apache pine hybrid (*Pinus ponderosa - Pinus engelmannii*) which may be quite drought-resistant, for planting in the western states.

FIGURE 7. – *Insects respect no boundaries. Defoliating insects sometimes attack thousands of acres of national, state and privately-owned forest lands. Here, a Forest Service plane sprays an insect-infested stand of Douglas fir* (Pseudotsuga menziesii) *with a DDT mixture to control the spruce budworm* (Choristoneura fumiferana). (*State of Idaho*).

Tree breeders have also selected trees from wild stands with outstanding characteristics. In the South, certain slash pine trees have fine-limbed, narrow crowns, but still have good growth rate. And in the northern Rocky Mountains native western white pines (*Pinus monticola*) have been found which by all the tests to date are naturally resistant to white pine blister rust. In every major timber region, studies are under way to determine the best races of the important timber species for planting in various locations. As in growing other crops, the tree farmer will profit by using improved varieties or hybrids.

Successful planting or regeneration is just as important as selecting the best trees for planting. Because many forest lands have not regenerated properly, planting is necessary on millions of acres. Through years of research American foresters have been studying how best to plant on a great variety of sites — on cutover land, on old fields, on strip-mined lands, and on brushfields. In every major planting region, tree planting guides have been prepared based on the best results of research. Research has shown, for example, that although pines can be planted successfully on old fields in the central United States, hardwoods do poorly here even though the land originally grew hardwood forests. Studies have shown that the sand hills of northwestern Florida and other places in the southern United States can be reforested with pine if the scrub oak and wire grass are removed. They have shown that old cutover land in the southern States can be seeded with longleaf pine by sowing from aircraft if the heavy seed is properly treated with bird and rodent repellants and if the land is scarified or the undergrowth is first burned. Through years of research and experience in planting in the southern United States, planting success of 80 percent survival is common. Research is continuing, however, to develop methods of successfully planting many of the hardwoods and of planting cheaply on the more difficult sites.

Many small woodlands require careful management or rehabilitation to make them produce at the maximum rate. Silvicultural studies and case histories of small forests under management show what should be done. For example, to improve quality young pine trees can be pruned up to about 50 percent of the live crown without decreasing the growth rate appreciably. Pruning of some hardwood trees is complicated by the fact that removal of the branches often results indirectly in the development of epicormic sprouts along the stems. Research has shown that judicious thinning will concentrate the growth in the selected crop trees although usually no more total growth is obtained.

The proper level of growing stock is being determined in a variety of types and sites. This information will tell the woodland owner how much he should reserve per acre following an intermediate harvest cut. In many eastern American forests a basal area of 70 to 80 square feet per acre is a desirable reserve and the owner can harvest periodically the crop trees which are in excess of this reserve. Studies are also in progress to find out the best ways to obtain natural regeneration of desirable species, such as by scarification of the soil, elimination of competing species, and by openings of proper sizes.

Years of carefully kept records show what woodlands will produce with a reasonable amount of management. From a 40-acre loblolly pine forest treated as a small woodland owner would handle it under good management, the annual return per acre has averaged about U.S. $12 over a 20-year period and the growing stock has been built up. Although this is one of the better management demonstrations, others on poorer sites or

with less initial growing stock have yielded an average return of U.S. $2 or more per acre per year while the growing stock was being built up. An upland mixed hardwood forest managed as a farm woodlot shows how a run-down stand can be rehabilitated. This 21-acre forest contained 65,000 board feet in 1952. In a rehabilitation cut, 23,000 board feet of less desirable trees were cut and sold at the roadside for U.S. $540. In five years the stand had grown back to 55,000 feet, growth rate is increasing, and the growth is being accumulated in higher-quality trees.

Forest management research is developing tools and techniques for a more efficient job of managing the woodlands. In the naval stores industry, research has developed new tools for chipping and scraping the tree faces, an acid technique to stimulate the flow of the resin, and better gutters and other equipment. Simple instruments have been devised for checking the stocking or basal area of the forest, effective methods have been found for killing undesirable trees in the stand, and more efficient systems of moving the product, the log, out of the woods, as tree lengths or on pallets, are being tested.

The results of this research are written up in a readily understandable style in Farmers' Bulletins published by the United States Department of Agriculture.

Forest products utilization research

Good forest management of small woodlands is highly dependent upon developing profitable uses for the previously unusable forest products now retarding the growth of merchantable trees. The national program of forest products utilization research is largely directed at developing uses for cull and defective trees left from previous harvest, species not now economically useful, and thinnings and improvement cuttings below the level of economic return. It is centralized by the United States Forest Service in the Forest Products Laboratory at Madison, Wisconsin, with additional on-the-ground research and service conducted at the nine regional forest experiment stations.

Utilization of wood as a raw material depends in part upon its competitive economic position with other substitute materials. One of the primary ways in which the cost of raw material may be lowered is to increase the efficiency of harvesting and transporting it to market. This is an important part of research to benefit the small woodland owner.

Research to develop better means for appraising quality of timber and for directing it to its most profitable use is not only helping the small timberland owner in managing his timber stand, but also aids the sawmill operator or other manufacturer in purchasing timber, selecting logs for alternate products, and quality control in manufacture. The end result is increased efficiency and potentially higher returns to the small timber grower.

Research to improve sawmilling, seasoning machinery, gluing, fastening, stabilization, fire retardance, protection from decay and insects all add to the usability and value of wood. Of particular value to the small woodland owner are those studies which improve the usability of species now unused because of difficulties of seasoning, machining, and nailing. Also, the timberland owner benefits from the development of simple methods of preserving posts, poles, and lumber from insects and decay.

Research in the utilization of little-used species and small trees for veneer products is being conducted to explore possibilities for use of this material for both decorative and structural purposes. Slicing ultra-thick veneer for special uses formerly satisfied by sawn products is also being studied. The possibility of composite products of veneer with other materials is being examined.

The upgrading of low-grade lumber, veneer, and plywood by "resin-paper" which is glued over the faces of low-grade lumber is another study which is being directed toward increasing utilization of the lower-grade timber which is now largely unmarketable and a major problem on small woodlands.

Possibility for increasing the use of the lower grades of hardwood lumber for structural purposes is being explored. The problem here is largely concerned with joining structural members. Both mechanical fasteners (nails, bolts, connectors, staples, etc.) and gluing are being examined. Solution of this problem could help create a market for many small woodland "problem" hardwoods.

FIGURE 8. – *Forest genetics research achieves hybrid vigor in pine. The short tree is a jack pine* (Pinus banksiana); *the tall one is a hybrid lodgepole-jack pine* (Pinus contorta-Pinus banksiana). *The U.S. Forest Service operates forest genetics institutes in the States of California, Wisconsin and Mississippi.*

In spite of all that can conceivably be done to utilize wood-as-wood, there is a need for developing large-scale pulp and chemical utilization of the little-used species and trees not suitable for other uses. Improvement of pulping processes for using hardwoods is continuing, but additional refinement is being developed.

In the chemical field, production methods for charcoal in low-cost kilns are being improved. Basic reactions of wood and wood components with physical and chemical agents are being developed to give data for the establishment of new industrial uses for wood as a raw material for industrial chemicals and other uses. Chemical and pulping research has already made a great increase in the number of species suitable for wood products and has enabled the small woodland owner to market many of his so-called " weed " species.

In addition to the research being conducted, forest products utilization is also being furthered by an action program to study regional utilization problems and to give advice and other assistance to industry and other processors of the small forest owner's wood on the possibilities of improving existing processes and establishing new industries. Co-operation is also being maintained with industrial and regional public institutions engaged in forest products utilization research. Education of qualified scientists in this field is being encouraged by a co-operative aid program in which assistance is being given to educational institutions to further graduate study.

Forest economics research action

A number of economic research programs in the United States are contributing to the improvement of small woodlands. Research in timber quality standards, market development, price and market information and timber production economics is being conducted by nine experiment stations of the United States Forest Service and by various state educational institutions and private organizations.

In the field of marketing research, a wide variety of projects has been undertaken by research agencies to provide information of direct value to farmers and other owners of small woodlands. As an aid in selling timber more effectively, for example, grades have been developed for certain species of logs and trees — notably grades for sawlogs intended for lumber production. These have included establishment and application of grades for eastern hardwoods and, for example, for ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*).

The practice of selling timber on grade, including both standard Forest Service grades and a wide variety of local grades specified by wood-using plants, is still highly variable in the United States. Much timber is still sold on a lump-sum basis and much of the timber cut is not utilized for the highest value products obtainable. Research on timber quality, selling methods, and marketing information is leading to definite improvements in the marketing practices of small woodland owners and higher returns from timber growing.

Considerable utilization economics research has also been conducted on ways and means of utilizing more of the low-value species and the woods and mill residues that have long been wasted. Use of sawmill residues has increased spectacularly in this country over the past 10 years. The resulting increase in efficiency of manufacture and intensity of wood utilization benefits both the wood-using plants and the small landowners who supply much of the timber for industry in the United States.

Research in the economics of timber production is likewise providing information that small as well as large landowners can use in planning forest production programs and in deciding upon profitable investments. Information on returns to be expected from tree planting, for example, provides direct guides to a large number of landowners interested in establishing new forests. The determination of forest earnings under different conditions also provides a basis for more exact determination of land values, both for the general buying and selling of property and for more specialized purposes such as tax assessment.

Summary

Seventy-three percent of all the commercial forest land in the United States is privately owned. There are 4.5 million small forest owners, who possess more than 55 percent of all the commercial forest land.

There are a number of action programs in the United States to improve small woodlands. But while there has been a great deal of forestry progress during the past 50 years, much remains to be done before the small forests can be raised to optimum timber production.

The national government, the state and local governments, forestry colleges, the forest industries, self-employed consulting foresters, and citizen-associations, are all working to achieve higher production on the small woodlands. As a further effort, the national forest service and the state forest services are now sponsoring joint meetings of small forest owners throughout the United States, at which they seek the opinion of these owners on the best approaches to the problem of securing better forest management.

Ten Years of Forestry Progress in Iraq

G. W. Chapman
FAO Technical Assistance Officer

Just over ten years ago, the Director-General of Agriculture in Iraq drew my attention to a large map of Iraq on the wall of his office in Baghdad. He gestured to the far northern extremities of the country and said:

"The forests of this country are all up there in the mountains along the borders with Turkey and Iran. We do not know exactly how extensive they are or how rich they are. We are afraid they are all being cut down and turned into charcoal. We want to put the forests on the map. We want to know how best to preserve them, and we want a new Forest Law — quickly."

This was the situation in January 1947.[1] A day or so later I met the Forest Section up at Arbil, a small provincial town on the northern plains and well placed at the hub of the great arc of mountains to the north and east. In those days the Forest Section of the Department of Agriculture consisted of an agricultural official, an accountant and a clerk. Two or three junior officials with diplomas from the Agricultural School near Baghdad were attached to the section and stationed out in remoter forest centers. There were also some 50 or 60 Qolchis — picturesquely costumed Kurdish villagers, all armed to the teeth and swathed in bandoliers of cartridges — who made up the corps of forest guards. These were posted at strategic points along the few highways leading from the mountains and charged with the task of controlling the contraband charcoal trade which, in the absence of any effective forest law, continued to flourish.

In those days there was never very much money to spare for forestry: the Forest Section's budget ran to about 15,000 dinars [2] a year — 90 percent of it for salaries, allowances and office expenses. There was little left over for tree planting, or other forest activities. This was, of course, before the days of big oil revenues.

Language was another difficulty too. Arabic is a rich language, a language for poets, philosophers and theologians. But it was hard to fit forestry into Arabic. There were two words for "forests" — *rabat* and *ahrash* — but none which could exactly describe such expressions as "watershed," "silviculture," "selection coppice" or even "forester." Few people properly understood what forestry meant at all, though there was an increasing number of Iraqis who felt an uneasiness about the way the mountain forests of gnarled and branchy oaks were disappearing into the kilns of the charcoal burners. Many held the unshakeable conviction that the only way to preserve the forests was to ban all cutting of trees notwithstanding the age-old usages of the mountain villagers who cut whatever they needed whenever the need arose.

It was not to be wondered at that forestry was little understood in Iraq, for nine tenths of the people lived in the treeless plains of the Mesopotamian delta or roamed with their sheep and camels up and down the wide expanses of steppe which divide the delta from the deserts on either flank. To most of these a forest meant the groves of date palms which border the rivers and canals throughout the delta. The only forest produce known to the peasants came from the palm fronds, whose leaves they wove into mats and baskets and made latticed furniture from the tough and springy midribs. All lumber used in the country had to be imported at a cost that limited its use to the towns.

Ten Years Later

Ten years or so in terms of forestry is not a long time: trees grow slowly and governments, even in the most highly developed forestry countries, often seem to match their gradual pace to the incremental rate of the forests. But, returning to Iraq in 1958, I was astonished and gladdened to discover what progress had and was being made.

The insignificant Forest Section at Arbil had blossomed into a General Directorate in Baghdad under the Ministry of Agriculture, with forest sections established in nine of Iraq's fourteen provinces. Many new men had come in who had gone abroad to universities and rangers' colleges and had now come back, understanding forestry, talking forestry, anxious to translate academic into practical accomplishments. In the northern provinces, forest sections were putting out branches into subsidiary forest centers. The old-time Qolchis had been expanded into a forest police division, uniformed and working under the discipline of regular police officers seconded to the Forest Service. A new forest law, enacted a year or two previously, incorporated in its preamble a clear-cut statement of the objectives of a national forest policy. Even an Arabic language of forestry was beginning to evolve from the provisional Arabic forest terminology drafted by a group of foresters drawn from the region.

Shortage of money was no longer a problem. The

[1] See G. W. Chapman. Forestry in Iraq, *Unasylva*, Vol. 2, No. 5, 1948.

[2] 1 dinar = U.S. $2.80.

FIGURE 1. – *Wattle fencing and thatching with grass and oak branches is used to stabilize erosion islands in the catchment forests of Northern Iraq.*

Courtesy, R. Baltaxe

annual forest budget had expanded by more than ten times its 1948 figure and, in addition, there is one million dinars allocated for forestry development schemes in the National Development Plan. There is, in fact, ample money to keep a still relatively small Department employed to maximum capacity.

But it seemed to me that one of the most encouraging features of the new forestry situation was the interest people were taking in forestry and tree planting throughout the country. Each springtime, for instance, sees impressive tree festivals organized in Baghdad and in all the provincial and district towns. These festivals usually start with a tree-planting ceremony, at which the school children parade and, after the official opening, plant trees along the sidewalks of one of the town avenues. The ceremonies are well attended by the public and by high officers of the Government. Most of these roadside plantings are well maintained and, year by year, the rows of trees stretch out further into the countryside along the new highways being built to link the provincial towns with the capital.

Irrigated plantations

Most impressive of all are the new irrigated plantations which the Forest Service has begun to establish in the treeless lowlands — the first step in a long-term policy designed to make Iraq near self-supporting in wood products. Many new exotic species are being introduced, among them eucalypts and hybrid poplars and subtropical pines of the Mexican group, though indigenous species — notably the black poplar and the eastern plane — as well as long-established exotics such as the casuarina or the eucalypts, *E. camaldulensis* and *E. microtheca*, form the bulk of the present plantations. There are well laid out on sites which are first carefully leveled to permit efficient irrigation and divided into compartments of 25 hectares.

Under the hot, desert climate of Iraq, water for irrigation is applied on a lavish scale, usually by pump lift from rivers and canals, and applications totaling 1,000 to 1,500 millimeters a year are not unusual. The land available, though sometimes troubled with salinity, is usually of good agricultural quality, and tree growth on these rich sites with abundant water and plenty of sunshine is phenomenally rapid. Poplars and eucalypts grow in height from 4 to 6 meters a year and in some of the earlier pioneer plantations — none more than ten years old — many of the trees are already large enough to yield telephone poles or small sawlogs. Mean annual increment rates of 20 cubic meters per hectare and more are expected and, if present plans for establishing 25,000 hectares of plantations in the coming twenty years go through, Iraq should be well set on the road to self-sufficiency in wood.

Machines play an important role in the creation of these new plantations. Bulldozers, graders and levelers clear the brush, level the land and push up flood control bands or the raised channels which distribute the water from the pumps to the farthest corners of the plantations. Wheeled tractors are used for plowing

the planting sections, opening irrigation ditches and furrows and, after the trees are planted, for weeding, spraying and other tending operations until such time as the young trees have closed canopy. A noteworthy feature of these plantations is the exceptionally low casualty rate in new plantings, for it is rare that beating up operations exceed five percent. Trees are usually spaced at 3-meter intervals in lines 3 to 4 meters apart and quite often the interrow spaces are used as a nursery for poplar cuttings, for transplantation subsequently into the next year's planting areas. In fact, many new and interesting plantation techniques are being developed and it is good to note that the Forest Research Institute is laying out experimental blocks in many of the new plantations to observe and to record the developing phases of this new and exciting silviculture.

The costs of establishment are relatively high — as much as 200 dinars per hectare — but this charge also covers the cost of machinery, vehicles, pumps, buildings and approach roads, and will doubtless fall as experience grows. The stumpage value on a 10- or 15-year rotation is expected to lie between 1,500 and 2,000 dinars per hectare and even higher in the case of the more valuable species. These yields compare favorably with any of the agricultural cash crops at present grown, and it might well be said that these irrigated plantations in Iraq represent in reality a form of farming with trees as the main cash crop.

Though most of the work is being concentrated at present in blocks of plantations ranging in size from 400 to 1,000 hectares, future plans embody schemes for extensive row-planting in the irrigated deserts newly opened to farming. In the 75,000-hectare Musayib Canal Project, for example, the Forest Service has a 70,000 dinar scheme for planting windbreaks along the banks of all the main and lateral canals and drains. These plantations are expected to serve as a demonstration and to give the initiative to settlers to plant tree rows and farm wood-lots in their own holdings. In fact, extensive and systematic windbreak planting is expected to have far-reaching effects on crop yields and may also lead to considerable economies in the use of irrigation water as a result of lowered evapotranspiration rates. Such plantations open a rich field for experimental work and it is to be hoped that the Forest Research Institute will grasp the opportunity thus afforded for investigating the influence of these row plantations in the extreme climatic conditions of the Mesopotamian delta.

Natural forests

While progress in the lowlands is perhaps more spectacular, there has been steady development in the indigenous mountain forests. These have been mapped and divided into broad categories based on the quality and density of the stocking. Of the 1,700,000 hectares of forestry land shown on the forest maps, about 900,000 hectares consist of exploitable oak forest, the remainder being alpine pastures and open parkland. Land settlement is well advanced in the mountain zone and systematic forest reservation has just begun. Excellent topographic maps on the 20,000 scale and a complete air-photo cover is available for the more detailed inventory of the forests which will follow reservation. More attention is being given to problems of watershed management, especially in the catchments of the huge new flood storage reservoirs planned or under construction in the mountains.

The Forest Service is certainly leading the field in this direction and has started several interesting forest development schemes in the mountain forests. Most of these have the dual object of reducing erosion and flash run-off and of enriching the oak forest by the introduction of coniferous species (mostly *Pinus brutia*, *Cupressus sempervirens* and *C. arizonica*).

Seedlings of these species require watering for the first two or three summers, after which they become established and survive on the winter rainfall. Watering is both difficult and costly, which rather limits the scope of the work, but nevertheless a number of promising small plantations are springing up at different places in the mountain zones.

The strict protection against grazing secured in all

FIGURE 2. – *Watering* Pinus brutia *seedlings in a mountain afforestation area. The seedlings require watering for the first two or three summers, after which they become established and thrive on the winter rainfall. Watering is both difficult and costly, which rather limits the scope of the work but, nevertheless, a number of promising small plantations are springing up at different places in the mountain zones.*

Courtesy, R. Baltaxe

FIGURE 3. – *Forest police protect the limited* Pinus brutia *forests near Zawita in Northern Iraq.*
Courtesy, R. Baltaxe

these projects has, however, produced a startling response in the rapid growth of native grasses covering the forest floor as well as a vigorous regrowth of cut-over and previously browsed oak coppice. Release from grazing alone is sufficient to secure a very marked improvement in erosion control, and since the forests are all more or less heavily grazed, it would seem that the improved management of forest range is likely to become the most important aspect of future forest policy in the mountain catchments.

Regulating the cutting of forests for fuel and charcoal still remains a problem. The charcoal trade, with its urban centers in the lowlands, has been prohibited altogether for the past three years and, though the Forest Service still cannot prevent entirely the flow of contraband charcoal, there is little doubt that a considerable reduction in charcoal consumption has ensued. Compared with ten years ago, there has been a substantial increase in the use of alternative fuels, such as kerosene, and the once ubiquitous charcoal brazier is becoming a rarity.

The Government has under consideration a scheme for rationalizing forest exploitation through the establishment of a charcoal monopoly operated directly by the Forest Department. This scheme offers a better means of controlling the illicit trade and would at the same time provide more regular employment for the forest communities. Recently a decision was taken to clear the forests lying below the high-water mark of the new Darhend-i-Khan reservoir by direct departmental action as a kind of pilot scheme to gain experience before embarking on the bigger project.

The Future

Perhaps one of the most astonishing factors in the development of Iraq forestry is the relative smallness of the forest staff which has carried progress forward so successfully in so many varied directions. The lack of trained foresters is about the most important factor restraining the impetus of forest development at the present time, and the obvious solution is both to take advantage of available schools elsewhere and to set up training facilities in Iraq.

This matter, too, has received careful consideration, and quite recently the Ministry of Agriculture has given the green light to plans for establishing a forestry faculty at the Agricultural College, which is to become part of the new University of Baghdad, and for building forester and forest ranger training schools. When these plans become a reality, the Forest Service will be able to get on a level with the ambitious development program lying before it, as recommended by the reports of FAO's Mediterranean Development Project.

Looking back over the last ten years, there can be no doubt that the Iraqi Forest Service has made a most promising start in the task of implementing the national forest policy. It is, however, only a start, and an immense amount of energy perseveringly applied is needed to preserve the forests in the vital mountain catchments and to build up by afforestation the wood supplies so badly needed by a rapidly-growing nation. Many more decades must elapse before these goals are achieved, but the auguries all seem to be most favorable for the future of forestry in Iraq.

Forest Tree Breeding Research

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In preparation for the World Seed Year, FAO is seeking to assist national campaigns aimed at improving seed quality and promoting wider use of such improved seeds. An important element in the production of better seed and superior trees is research relating to genetics, and particularly to forest tree improvement. The subject of forest tree breeding research is being treated by Professor Mergen in two parts. In the present issue, he deals with individuals tree selection, progeny and clonal tests, and vegetative propagation. In the next issue of Unasylva *a further article will deal with hybridization, controlled pollination, and induction of flowers and fruits. Forest tree breeding research is potentially of the greatest significance to foresters and forest products industries.*

Interested readers are invited to send their comments to the Director, Forestry and Forest Products Division, FAO.

Tree planting programs are being expanded throughout the world. The demand for forest tree seed and for planting stock has increased rapidly, and frequently exceeds the supply. Under such conditions the nurseryman does not have as much control as is desirable over the genetic quality and origin of the seed. Nevertheless, very much more serious consideration than in the past is now being given to *what* is planted.

Tree Selection

To alleviate the seed-supply problem, and to assure seed from trees of known quality and origin, seed orchards and seed production areas are being established. In these forest stands, selected trees are favored and propagated for the purpose of producing high-quality seed. Trees in the seed orchards are selected for a variety of different desirable traits, such as high degree of resistance to a particular disease, rapid growth, good stem form, good natural pruning, wood of high density, or high yield of oleoresin.

For seed production areas the best natural or planted stands are cleared of the inferior trees, and the desirable trees are maintained for seed production. These potential seed trees are selected purely on the basis of general outward appearance (phenotype), and the true genetic make-up (genotype) of these selected seed trees cannot be determined until the planting originating from these trees are old enough for evaluation. Tree selection for seed production areas is fairly simple and consists of leaving the best 10 to 50 trees per acre evenly distributed through the stand, so that each selected tree can attain maximum crown development and fruitfulness.

As mentioned, selection is purely visual, but if carried out in even-aged and well-stocked stands, the selected trees will normally be those that have survived competition and were best fitted for that particular site. This type of selection will probably not upgrade the resulting plantations much above their parents, but will maintain a genetic *status quo* in the resulting plantations, and will assure seed of known origin from good phenotypes at a cost competitive with that from commercial sources. Above all, it will tend to counterbalance the dysgenic practices of collecting cones from isolated, deformed trees; for the characteristics that make a tree attractive to the commercial collector (extreme limbiness and a large crown, along with poor natural pruning) make the tree an undesirable seed source from a forest manager's point of view.

Within the general field of individual tree selection, however, the greatest efforts have been spent not on selecting the best trees within a given stand, but within a particular locality or within its entire range. Emphasis is placed on the selection of individual trees for use in seed orchards. This type of selection is the basis or foundation for the majority of tree-breeding programs that have as a goal the mass production of trees that are outstanding in a particular characteristic. These selected " plus " or " superior " trees supply seed and pollen for progeny tests, and cuttings for vegetative propagation. They also will serve another useful purpose, namely that of preserving outstanding germ plasm for future generations. Through the forests all over the world, foresters are looking for pines with resistance to insects or disease, spruces with exceptional growth characteristics, maple trees with a sweeter sap, chestnut trees with ability to withstand the chestnut blight, or birches with curly grain, to name just a few from a large list of objectives (Figure 1).

Although selection of outstanding forest trees has been under way for some time, there is as yet little precise statistical information available on which to base general predictions. The outcome or benefits of a particular type of selection need to be evaluated for each case. In one instance, selection of outstanding trees along with their subsequent mass propagation might be a fruitful line of approach while, in other instances, where the desirable traits are under loose

FIGURE 1. – A. Pinus taeda *selected for outstanding growth characteristics. At the time the photograph was taken the tree was 69 years old, had a height of 30 meters, and a d.b.h. of 50 centimeters.*

Courtesy, Texas Forest Service, College Station, Texas, U.S.A.

FIGURE 1. – B. "*Plus*" *tree of* Pinus laricio *var.* corsicana *on the isle of Corsica. The age of this tree is about 220 years, the height is 51 meters, and it has a d.b.h. of 90 centimeters. A ladder of* 38 *meters was necessary to reach to the lower part of the crown.*

Courtesy, M. Lemoine, Nancy, France

genetic control or where legitimate selection and evaluation cannot be made, this approach will yield no beneficial results at all. The total amount of improvement in a particular quality, and the rate at which the improvement will become available by selection will depend on various factors, such as the intensity of the selection procedure, the amount of genetic variation present in a particular species, the degree of heritability of the character under selection, and on the method of propagation.

Intensity of selection refers to the standards set up before one starts to look for plus trees. Selection can be on the basis of percentage of superiority, e.g., 100 percent faster growth rate than the average tree of the same stand; the best tree in a group of 100, 1,000, or 10,000 trees; or the tree that deviates by 4 standard deviations from the mean. In selection for disease or insect resistance, a choice is made of trees not affected or trees affected which were able to throw off the attack.

Selection is effective only within the range of genetic variation that is present in a species. Because in the process of selection and intraspecific controlled pollinations, no new genes are introduced into the gene pool of the species, we must have the required genetic variability to begin with, lest selection yield no beneficial results (Figure 2).

Heritability is an index of the transmissibility of the selected characteristic, and expressed in statistical terms it is the effect of the genes in relation to the total amount of variability. Therefore, the greater the genetic effect, the larger the index of transmissibility. Because heritability consists of two components — genetic and environmental — it can be modified by changing the environment.

The method of propagation plays a very important part in determining the rate at which improvement can be achieved. If the desirable traits are under rigid control, and the tree lends itself to economical multiplication by the rooting of cuttings, superior planting stock can be made available immediately on a limited scale. If, at the other extreme, the selected tree has to be reproduced sexually when mature and the rate of genetic improvement per generation is slow, a hundred or more years might elapse before practical benefits are obtained.

Rigid standards for selecting superior trees, based on the progeny data on hand, should be developed without further delay for all the commercial species so that their genetic potentials can be fully utilized. The standards and methods for selection should be worked out by joint co-operation between forest managers, wood users and forest geneticists. These standards will need to be modified as the results from replicated progeny tests become available. In these specifications individual traits should be stressed, such as high yield of extractives, rapid growth, or resistance to insects or disease. Some foresters also place emphasis on a combination of desirable traits, e.g., exceptional height and diameter growth along with straight grain, dense wood, and high alpha-cellulose content. If trees are selected for only one desirable trait, selection is most effective; the degree of difficulty and chances of failure increase in a geometric progression with the number of traits used, unless there is genetic linkage between these traits. Under most conditions, selection will be effective only if practiced on one or possibly two characters at a time.

Field selection can be facilitated by providing foresters and woodsmen with illustrated guides for the various species so that they may be on the look-out for exceptional trees. The theoretical " plus " trees can also be described in statistical terms as a basis or guide for their recognition.

For some traits, selection must be at rotation age, while for traits that " mature " in seedlings or young saplings, the " plus " trees can be selected in nursery beds or young plantations. For example, longleaf pine with a short (one- to two-year) grass stage, or trees with exceptional cold hardiness, have been selected in the nursery beds. Selection in nursery beds, however, is only of value if the characteristics for which the seedlings were selected in the juvenile stage maintain their attributes through to maturity. If selection in the nursery is feasible, advantage should be taken of this method, for it allows selection amongst millions of even-aged seedlings growing under uniform conditions. Nursery bed selection is more effective when the seed is graded by size before sowing, for this eliminates part of the variation in initial height growth and vigor.

Selection of superior trees definitely has a place in forest tree improvement programs, as has been shown by the results of F_1 progeny tests from parents selected for oleoresin yield, fibre characteristics, production of rubber, resistance to drought, resistance to disease, and over-all pattern of growth.

However, for most traits, as long as selection is based strictly on phenotypic or outward appearance, the ratio of " plus " genotypes to selected " plus " phenotypes will be low. Accurate diagnostic methods of selection are needed that will aid selection on the basis of morphology. From the progeny tests, methods will be evolved that use biochemical and refined physical tests of those characteristics that are the underlying causes of the desirable traits. Examples of some tests that might be used are: the tannin content of bark in chestnut as an indication of resistance to the chestnut blight, viscosity of oleoresin as an index of gum yielding ability, or resin on pine branches as an indication of resistance

FIGURE 2. – *Extreme variation in early growth (" grass stage ") of* Pinus palustris, *growing in a progeny testing plantation at Olustee, Florida. The four trees that are identified in the photograph are all 12 years old and received the same treatment from seed collection through to field planting. Tree A is still in the grass stage while Tree D has a height of 12 meters and is bearing cones. Tree D was used in controlled pollinations as part of a program to develop a strain of* Pinus palustris *with a short grass stage.*

Courtesy, U.S. Forest Service

to the resin midge. The development of these tests should not be considered as an end in itself, but they should help to speed up progeny tests for they will allow one to use very young plants.

In general, the intensity of selection should depend on what the tree is to be used for, and on how much time and effort (money) one contemplates spending on it. If the tree is to be used for extensive vegetative propagation along with controlled pollinations and subsequent progeny testing, considerable time and effort need to be invested in the selection phase. It is advisable to mark, describe and catalogue each individual tree so that this information may be exchanged between the various tree breeders, and also to protect the trees from the axe.

The number of catalogued "plus" trees that have been selected throughout the world is quite impressive. In Sweden alone, there are about 3,000 catalogued trees that were selected for their outstanding height and diameter growth, and exceptional growth and good form (Figure 3). These trees form the core of the Swedish tree improvement program (Streyffert, 1958). In Finland, by 1953, approximately 500 pines, 200 spruces, 100 birches along with some 200 trees of other species had been selected, measured in detail, and rendered identifiable in the field. Some of these selected trees are located in forest stands north of the Arctic Circle (Anonymous, 1953).

When specifications for superior trees are prepared, one should keep in mind that the results of a program of controlled breeding will not be available on a commercial basis until after some 30 to 50 years have passed. With our rapid changes in utilization standards and conversion practices, some of the specific tree requirements will have been taken care of by technological advances by the time the "improved" trees are available. Therefore, one should select for traits that can still be expected to be of importance some 30 to 50 years hence.

Progeny and Clonal Testing

Superior tree selection in the field is based on the outward appearance or phenotype of the tree. A tree as it stands in the forest — the phenotype — is the expression of the interaction of its genetic potential, or genotype, with that particular environment. The superior characteristics of a selected tree can, therefore, be due to either a favorable environment, or to a desirable genotype, or most likely to a combination of these two.

Without any further testing, it is not possible to ascribe a particular characteristic as being determined by hereditary factors, or by environmental forces. For example, a blister-rust-free mature eastern white pine tree can be either the result of no infection by the spores, or the tree might be resistant to the disease.

Figure 3. – *Three* Pinus sylvestris *"plus" trees selected by the Society for Practical Forest Improvement in Sweden.*

Courtesy, Dr. Arnborg, Uppsala, Sweden

FIGURE 4. – Pinus elliottii *trees in progeny tests by the Ida Cason Callaway Foundation, Pine Mountain, Georgia. This is a combination of a one- and two-parent test; the trees are 4 years old from seed and are planted at a spacing of 10 × 10 feet (3 × 3 m.) to permit expression of crown form and fast, early growth.*
Courtesy, Ida Cason Calloway Foundation, Pine Mountain, Georgia, and U.S. Forest Service

Similarly, a Scots pine tree with a clear straight trunk might have shed its branches as part of its normal growth habit (genotype), or at one time it might have grown under heavy competition which resulted in a clean, straight bole. The only possible way to isolate the effect of the genotype and that of the environment is either to multiply the tree asexually and observe the propagules under a uniform environment, or to study its offspring (progeny).

Occasionally, nature makes small progeny tests for us. For instance, in an abandoned field on the Osceola National Forest, in Florida, U.S.A., the natural regeneration under an isolated slash pine that has a distinct forking habit, starts to fork at the same height from the ground and is similar in over-all appearance to the isolated parent tree. Such occurrences in nature point towards genetic differences, but controlled progeny studies are needed to obtain definite evidence that the selected characteristics, or tendencies for these characteristics, are under strong genetic control. The progeny test, although of a time-consuming and expensive nature, is essential and it will determine the amount of economic benefit to be derived from the multiplication of the selected trees. These tests form the backbone of tree improvement programs and, therefore, should be planned expertly, and executed with care. Unless the description of a superior tree is backed up by the evidence from progeny tests, these descriptions will have no use in tree improvement work, for they merely outline what a desirable tree looks like.

The rigidity of genetic control of a selected trait can be assessed by both clonal outplantings and by progeny tests. For the clonal tests, the selected trees are propagated vegetatively, and these propagules are then planted out under uniform or known environmental conditions. Propagation may be by rooting cuttings, air-layering, rooting needle fascicles, root suckers, or by grafting. Grafting, however, is not satisfactory if adaptability to a particular soil, root growth, and other related characteristics are being evaluated.

Selection of superior forest trees is generally carried out over large areas, and sometimes selected trees within a species are separated by a distance of several thousand miles. This makes it impossible to evaluate objectively the relative merits of each tree. However, by propagating these trees vegetatively, they can be brought together and outplanted in test plantations on various sites for comparative purposes.

These clonal tests, as they are called, have been used to determine if a tree is actually resistant to a certain disease or has escaped damage merely because the disease-causing organism was absent; to establish the

FIGURE 5. – *Roots induced on A*) Pinus elliottii *and B*) Picea abies *by air-layering branches that were treated with indolebutyric acid.*

Courtesy for Figure 5 A, U.S. Forest Service

yield and quality of oleoresin of slash pine for naval stores purposes; to evaluate anatomical characteristics and growth traits such as needle color, branching angle, or over-all phenology. Such tests help to determine the dependence of the selected traits on the environment, but shed little light on the mode of inheritance or combining ability. They may show results quicker than progeny testing, however, inasmuch as they a low one to postulate the genotype, and obvious failures can thus be eliminated before their progeny is tested.

Dr. Larsen in Denmark was the pioneer in the use of vegetatively propagated trees as a means of comparing the genotypes of selected trees. In these " tree-shows," as Dr. Larsen calls the clonal tests, expression is sought of a uniform environment on several genotypes (Larsen, 1956). However, the only possible way to learn the mode of inheritance, or obtain an estimate of the degree of heritability of certain traits, is by studying the progeny from the selected trees. These progeny tests reveal more information on the genotype of the selected trees with reference to their breeding value than do the original trees themselves. For use in commercial plantations certain traits need to be known and the information on some of these cannot be obtained from a single tree; for example, yield per hectare.

Depending on the objectives of a tree improvement program, and depending on the manpower and physical facilities available, progeny tests with seed consists of either " one-parent " tests or " two-parent " tests. For the one-parent tests, open or wind-pollinated seed is collected and the female parent is the only one specifically known. In the two-parent test the pollen source has been controlled (by cross-pollination or selfings) and both parents are known. Considerable information can be obtained on the inheritance pattern by the " one-parent tests," but the tests may need to be repeated over a period of several years, because the male parents (pollen supply) often change from year to year on account of the climatic conditions prevailing at the time of pollination. These tests, although less refined than the two-parent tests, can be started without any delay, but their evaluation will require the skill and time of trained tree breeders. They are especially useful if information is desired on how much improvement in a certain characteristic is obtainable by collecting wind-pollinated seed from superior trees.

The field designs for the progeny tests, especially the two-parent tests, present considerable problems, many of which are of a paradoxical nature (Figure 4). The number of trees in each progeny group is important, for it must be great enough to keep the sampling error down. When a large number of trees is used in each block the land area to be used is increased, which in turn increases the degree of heterogeneity in the environment. In addition, the traits under investigation partially determine the error term and thus influence directly the size of the progeny. The amount of variability between the different progeny groups is mostly not uniform and this introduces another variable. In addition, one often has to deal with progeny groups of unequal number on account of failures in seed-set or loss to rodents and birds. This difficulty can be partially overcome by balanced, or partially balanced, incomplete block designs. The number of trees per hectare throughout the test will also vary, starting with a high number at the beginning and ending up with a smaller number as the trees grow larger. Depending on the method of thinning, such as systematic versus nonsystematic thinning, the error term can be consid-

erably changed. Another consideration, not always satisfied, is that the environment has an additive effect on the genotype, and that this effect is of equal magnitude on each genotype. Some progeny tests reveal a considerable amount of information on the performance of the various progeny groups, without necessarily giving adequate information on the selected parents. Tests should be so designed that maximum correlation is obtained between the performance of the progeny and the genotype of the parents (Strand, 1952). Unless adequate replication and complete randomization is possible, it is aways best to check the design with a well qualified statistician before planting the trees in the field, rather than at the time when evaluation is to be made.

With the advance and interest in controlled environment rooms, speed-up flowering and progeny tests under rigid environmental control will permit more rapid and precise testing for certain characteristics, especially when these tests can employ biochemical or physical techniques rather than over-all growth measurements. Because the field of progeny testing of forest trees is fairly new, considerable progress could probably be made by pooling the knowledge of the geneticists, the physiologists, and the biometricians.

Vegetative Propagation

The technique of vegetative propagation has a direct application in forest tree improvement programs, because it allows genetically superior trees to be multiplied, 1,000 or even 10,000 times, without altering their genotype. When trees are reproduced vegetatively, they are multiplied without fusion of the male and female reproductive cells. This asexual reproduction produces plants (propagules) true to form without any different or new traits from a second parent, unless mutations occur. Thus, vegetative propagation is an essential tool in multiplying and preserving valuable germ plasm, and in estimating the genotype in clonal tests.

If a superior tree is easily rooted, it can be increased many-fold without delay. Some of the hardwoods, such as willow, poplar, or locust, are good examples of this. With most species, however, and especially the conifers where vegetative propagation on a large scale is economically impossible, multiplication has to be by seed. For this purpose seed orchards are being established with grafted stock or rooted cuttings from superior trees, and these orchards are then managed solely for the production of high quality seed.

Although of great silvicultural importance, determined attempts to propagate vegetatively forest trees that do not normally root or sprout were only started some 20 to 30 years ago. Considerable research is being conducted on finding methods to root cuttings of species refractory to rooting. Tests have been made with numerous types of media, varied temperature and light regimes, different treatments with hormones, nutrients, fungicides and insecticides, and throughout the different seasons of the year from trees of various ages (Mergen, 1955). Despite these concentrated efforts, there are still many species where it is extremely difficult to obtain cuttings with adequate root systems. With the advent of thin plastic sheets it has been possible to induce rooting by air-layering branches on trees that do not root well from cuttings. The air-layering technique, although over 2,000 years old, has only recently been used to propagate forest trees for use in improvement work (Figure 5). Certain conifers can now also be propagated by rooting individual needle fascicles.

Figure 6. – *Heteroplastic grafting of* Pinus elliottii *on* Picea excelsa.

A. *View of plant after they were grafted for one year.*

B. *Cross-section through graft union: above, pine; below, spruce.*

In agriculture, various plants have been propagated vegetatively through many centuries without much apparent loss in vigor, and so far there is no likelihood of a reduction in vigor in trees propagated vegetatively. There is, however, danger that because all the members of a clone are genetically identical, a disease infection or insect attack will spread rapidly once it is established. There is evidence of this disadvantage in some of the hybrid poplar clones that have been propagated by cuttings, especially where an entire stand consists of one single clone.

Depending on the species there is no or little difference in the growth pattern of cuttings taken from different parts of the same tree, and once they become established the rooted branches appear similar to trees that grew from seed. There is strong evidence, however, that in some species cuttings from lateral branches will always have a plagiotropic growth. *Araucaria* provides a good example of this type of behavior.

Perhaps the greatest use of vegetative propagation lies not in its use as a direct means of multiplying superior trees for commercial use, but as a tool in facilitating studies. As mentioned above, selected trees are mostly scattered over the range of a species which makes it difficult to control-pollinate a large number of trees within a season. Scions (branches) from these trees are therefore grafted on stock planted close to the laboratories to facilitate the breeding work. By this method germ plasm of the selected trees is also preserved should the parent trees die, and scions from one selected tree can be established in many locations throughout the world. There are, for instance, Douglas firs growing in Denmark that have the identical genotype as trees in the natural range in the U.S.A. (Larsen, 1956).

In addition to these considerations, vegetative propagation permits one to transplant a scion onto a root stock that can survive under particular conditions; change a dioecious tree into a monoecious tree; propagate bud mutants; induce flower formation; and study virus transmittal and resistance mechanisms. Intergeneric and interspecific grafts (heteroplastic) are also possible, and these afford a great opportunity to study the translocation of solutes (Figure 6). Not all graft combinations within the same genus, however, are completely compatible, but this incompatibility is being used to good advantage with several fruit trees to induce earlier flowering.

Great advances have been made in the general field of vegetative propagation of forest trees, but intensive studies on the physiology of root formation are needed to solve the problem of those trees that root with great difficulty. The method of vegetative propagation has proved its usefulness in various phases of forest tree improvement work, and, with the expansion of basic research with forest trees, its usefulness in other branches of forest biology will be recognized.

Summary and Conclusion

Forest tree breeding is still in the early stages of development – in the descriptive phase of the forming process. During the past few decades, considerable knowledge has been gained on the genetic variability within our tree species, on their physiology, on how to test the inherent variability, and on how to use this information advantageously in silviculture. More work, both basic and applied, is necessary to advance this field and, during this period and as new information is obtained, many current ideas on tree selection and progeny testing will be modified and changed. It is however, a field that can look forward to contributing greatly to the over-all practice of forest management.

References

Anonymous, 1953. Forest tree breeding in Finland. *Finnish Paper and Timber* 6: 73-74.

Larsen, C. S. 1956. *Genetics in Silviculture*. Oliver and Boyd, London. 224 pp.

Mergen, F. 1955. *Vegetative Propagation of Slash Pine*. U.S.D.A.; Southeastern For. Exp. Sta. Paper 54. 63 pp.

Strand, L. 1952. Progeny tests with forest trees. *Hereditas* 38: 152-162.

Streyffert, T. 1958. *Forestry in Sweden*. Oregon State College Press, Corvallis, Oregon. 55 pp.

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Equipment for Pest and Disease Control

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The application of pesticidal dusts, dilute sprays, concentrated sprays and aerosols, for the control of pest and diseases in agriculture and forestry, has become widespread. The method has not approached its potential of use and many areas could be treated more efficiently and effectively, and at a lower cost, if better data and information were readily available. This paper, to be concluded in the next issue of Unasylva, *describes present practices in North America and, besides dealing with insecticides and fungicides, includes information on equipment and methods for applying the new herbicides, silvicides, foliage nutrients and fertilizers. The possible harmful effects of the extended use of chemical control methods in agriculture and forestry are of much concern to FAO and many other agencies. These effects are being studied but much more data needs to be collected.*

Fundamentals of Application

Particle size of insecticides and its relation to application, distribution and deposit

Recent developments in the application of insecticides in the form of smokes, liquefied-gas aerosols, and finely atomized sprays, with equipment operated from the ground and from aircraft, have attracted attention to the significance of particle or droplet size as a factor in determining deposit, distribution, and effectiveness of dusts and concentrated sprays (Potts, pages 716 to 719). Under field conditions extremely minute individual particles of finely ground dusts, insecticidal smokes, finely atomized aerosols, and concentrated sprays are not deposited on the surface of plants, insects, and other objects. Such objects are surrounded by a film, or field of resistance, through which minute particles cannot penetrate. An electric field and air cushion around such objects may cause a repulsion of minute particles. Microclimatic conditions caused by difference in temperature, humidity, and weight of air near such objects produce air currents which carry away minute particles. Deposit is particularly light on warm, sunny days, and often there is a difference in temperature of as much as 10° F. between the sunny and shady sides of a leaf. Less deposit has been noted on the underside of cup-shaped or crimped leaves than on the upper surface.

Larger individual particles, whether dry or liquid, as well as groups or agglomerates of small dust particles, are heavy enough to penetrate the film of resistance and make contact with the surface of leaves, insects, and other objects.

Dusts

A series of studies conducted from 1926 to 1935 brought out the following conclusions concerning dusts:

Small individual dust particles do not give a good deposit. Dust clouds consist of mixtures of individual particles and groups, which may be composed of 25 to 300 individual particles (Potts 1940). Such groups of dust particles may settle on a surface, but do not adhere well. After dust is expelled for considerable distance from a blower, these groups of particles do not tend to break up nor do the individual particles in the cloud tend to coalesce.

Dust particles of heavy substances, such as barite, deposit somewhat better than do particles of light materials, such as derris, although from the standpoint of deposit the weight of the individual particles of a material is not so important as the presence of agglomerates in the dust cloud.

Proportionately more dust is deposited from a cloud of heavy dust expelled from a blower at a low velocity than from a cloud of light dust expelled at a high velocity and with a large volume of air.

Dust applied at a high velocity penetrates the resistant film around objects near the blower and deposits on them; however, at several feet from the blower the effect of high initial velocity is lost. This explains, in part, why ground equipment may never be very effective in dusting large trees.

The fineness of a dust, as indicated on the package or container, is not a criterion of its depositing qualities. The following insecticides are listed in descending order of the proportion of dust deposited on the foliage: sulphur, lead arsenate, derris and cube, pyrethrum, and cryolite. Sulphur particles are fairly large, as compared with those of the other materials. Lead arsenate particles are heavy and very fine (mostly less than 2 microns in diameter), but when applied this material forms groups of particles. Derris, cube, and pyrethrum dust particles are light and coarse. Cryolite dust has a greater tendency than most materials have to break up into individual particles upon application. It gives a lighter deposit than lead arsenate, but the deposit can be considerably increased by adding 10 or more parts of pyrophyllite to each part of cryolite.

Dust swaths applied by aircraft are often several hundred feet wide but their effective width is seldom more than 30 to 50 feet, the effectiveness being confined mostly to that part of the swath where a deposit of agglomerates, or particle groups, exists.

Table 1. – Size and Number of Droplets Deposited per Unit Area by Distributing 1 Gallon of Liquid Uniformly over a Surface of 1 Acre.[a]

Actual diameter, microns	Volume, cubic microns	No. of droplets, per square millimeter	No. of droplets, per square inch
1	0.52	1 780 125	—
2	4.2	222 516	—
3	14.18	65 930	—
4	33.6	27 814	—
5	65.6	14 242	—
6	113.4	8 241	—
7	180	5 197	—
8	269	3 476	—
10	525	1 780	1 148 100
12	907	1 030	—
13.5	1 289	725	—
15	1 772	527	—
17.5	2 814	332	—
18	3 062	305	—
20	4 200	222	143 190
24	7 257	129	—
25	7 442	125	80 625
30	14 175	66	42 570
35	22 507	41.5	26 767
40	33 600	27.8	17 931
45	47 838	19.5	12 577
50	65.520	14.3	9 224
55	87 343	10.6	6 837
60	113 400	8.2	5 289
70	180 007	5.2	3 354
80	268 800	3.5	2 157
90	382 725	2.44	1 574
100	525 000	1.78	1 164
110	699 000	1.33	856
120	907 000	1.03	664
130	1 153 000	0.81	530
140	1 440 000	0.65	425
150	1 771 000	0.53	347
160	2 150 000	0.43	277
170	2 579 000	0.36	232
180	3 061 000	0.30	194
190	3 600 000	0.26	168
200	4 200 000	0.22	142
220	5 590 000	0.17	111
240	7 257 000	0.12	78
260	9 227 000	0.10	65
280	11 528 000	0.08	52
300	14 175 000	0.066	43
400	—	0.028	18
500	—	0.014	9
1 000	—	0.0018	1.1

[a] Equivalent to 934,568 cubic microns of liquid per square millimeter.

Concentrated sprays

The failure of dusts to deposit and adhere satisfactorily on foliage has led to the development of highly concentrated insecticidal sprays and the application of these concentrates as finely atomized mists. This method permits coverage with a lower volume per acre. Although fine atomization is necessary to obtain adequate distribution with low rates of application, the droplets must be large enough to give a satisfactory deposit on foliage and insects. There is little deposit of droplets less than 20 microns in diameter; in fact, very few are deposited if their diameter is less than 25 microns, unless the droplets are moving at high velocity. The initial deposit of finely atomized sprays is several times as great as that of dusts. The loss of deposit caused by rain and wind makes the difference between dusts and atomized sprays even more pronounced in favor of the sprays.

Droplet size as related to volume and number of drops per unit area

The number of droplets of given size that would be deposited per square millimeter and per square inch (645 square millimeters) by the distribution of 1 gallon of spray (3,785,000,000,000,000 cubic microns) uniformly over a surface of 1 acre are shown in Table 1. A droplet diameter of 40 to 70 microns would result in a deposit of 17,931 to 3,354 droplets per square inch, and a diameter of 80 to 100 microns, a deposit of 2,157 to 1,164 droplets per square inch.

For the application of concentrated sprays with air blast type ground equipment the optimum range for diameter of droplets should be about 30 to 80 microns with a mass average diameter of 40 to 50 microns and for aerial application about 70 to 100 microns, both depending on the density and type of the insecticide, the volatility of the carrier, the plant growth, the kind of insect, the type of distributing device, and the atmospheric conditions. Under certain circumstances, which are discussed later in this paper, the droplet size for aerial application should be considerably greater. It will be seen in Table 1 that a slight change in diameter

Table 2. – Diameter of Particles in Liquid-in-air and Solid-in-air Disperse Systems

Category	Diameter range, (microns)	Numerical average diameter, (microns)
Liquid-in-air disperse systems		
Spray	150 to 3 000	750
Coarse mist concentrate spray	51 to 500	175
Medium fine mist spray	60 to 350	75
Fine mist spray	10 to 50	30
" Wet " misty fog	10 to 50	35
" Dry " fog	1. to 10	5
Aerosols (fine)	1. and smaller	0.4
Aerosols (coarse)	2 to 4	3
Solid-in-air disperse systems		
Dust	Larger than 10	—
Cloud	0.1 to 10	—
Smoke (most of particles in aerosol size)	5. and smaller	—
Aerosol	Less than 4 microns	—

changes the volume and number of droplets materially. For example, when the diameter is 20 microns, there are about 8 times as many droplets as at 40 microns diameter; nearly 16 times as many at 40 microns diameter as at 100 microns; and about 125 times as many at 100 microns diameter as at 500 microns. At 50 microns diameter there are about as many droplets in 1 gallon of mixture as in 143 gallons when the diameter is 260 microns. In any spray pattern there are proportionately a great many more small droplets than large ones, but the greater volume of spray is in the larger droplets.

In aerial application the use of a larger droplet is necessitated by wind, upward air currents due to heat radiation, layers of heavy, humid air above the treetops, and small irregular areas and rugged terrain. Low flying over large areas of level terrain makes practicable the use of smaller droplets, and therefore lower gallonage, at lower costs. For low flying over crops it might be practicable to use average droplet sizes as small as 60 to 70 microns. Except where it is necessary to kill insects under heavy canopy, larger droplets would be preferable for the treatment of forested areas.

Droplets of high specific gravity (1.3 to 1.6) can be deposited in smaller sizes than those of lower specific gravity (0.8 to 1.0). For droplets with a specific gravity of 1.0, and of various diameters, the time required to fall 50 feet, in ordinary still air at a temperature of 23°C., is as follows:

Diameter, microns	*Time*
200	13.0 seconds
100	51.0 seconds
80	1.3 minutes
50	3.4 minutes
40	5.2 minutes
20	21.0 minutes
10	1.4 hours
5	5.5 hours
1	5.0 days

Upward or downward air currents will change the rate of rise or fall, but wind velocity does not alter it (Miller 1935, page 160). The rate of fall of droplets of different sizes was computed by Stoke's law. Other things being equal, the smaller the droplets and the longer they float in the air the greater the evaporation and drift. Temperature, humidity, wind velocity and chemical characteristics also affect evaporation and drying of the particles. Considerable evaporation reduces the size of the drops and makes them fall more slowly and drift farther. Some increase in size and weight of falling particles has been obtained by the addition of Yumidol (a hygroscopic hexahydric alcohol). Phosphorus pentoxide, magnesium chloride, and calcium chloride particles greatly increase in size and weight as they float in the air, but when mixed with an insecticide these chemicals cause injury to some kinds of foliage.

The distance that a droplet 100 microns in diameter and having a specific gravity of 1.0 would drift while falling 50 feet in air moving parallel to the ground are as follows:

Miles per hour	*Feet*
0.25	22
0.5	45
1	87
2	175
3	265
4	348
5	435
10	765

A droplet 200 microns in diameter should drift practically one fourth and a 50 micron droplet about four times the distance given.

For application of liquids very small droplets, 4 to 40 microns in diameter, can be obtained by atomizing either with liquefied gas or with mechanical atomizing equipment. To deposit on the foliage the same number of droplets of given size by liquefied gas as by the mechanical method, it is necessary to apply a larger volume of liquid, the quantity depending on the proportion of liquefied gas in the solution.

Thermal smoke aerosols

Thermal aerosols have a field of use for some types of enclosures and indoor treatment. They do not promise a particularly important place in field application, in spite of the spectacular appearance of smoke clouds. An expressed virtue of smokes is that they can be drifted for long distances and deposited on the wings, legs, and antennae of small insects in flight, like mosquitoes and black flies.

The main weaknesses of insecticidal smokes are as follows:

1. An extremely small percentage of the insecticide is deposited.
2. They cannot be directed against a breeze or to any desired height.
3. The intense heat required breaks down certain chemicals.
4. There is often a fire hazard.
5. Suspensions of wettable powders usually cannot be applied.

Figure 1 shows a method of applying smokes, using a combustible fuel for heat energy. Arsenicals, rotenone, pyrethrum, nicotine, and oils were applied with this method in experiments by S. F. Potts and D. F. Barnes from 1927 to 1929 under essentially all conditions. The deposit out-of-doors averaged only about 2 percent as great as when the same quantity of insecticide was applied by hydraulic sprayer. Efforts to increase the particle size were not very successful, because when particle size was increased enough for deposition the particles were not projected more than a few feet from the applicator.

FIGURE 1. – *Smoke aerosol application to gypsy moth infested woodlands.*

Dust particles may be coated in the air by small droplets of oil, if the mixing takes place either in a vacuum or under pressure.

Liquefied gas aerosols have a field of potential use that is more restricted than for concentrated sprays, but is far greater than that for smokes.

Fine atomization is necessary to obtain adequate distribution with low gallonage, but the droplets must be large enough to deposit on foliage and insects. Apparently for ground application most of the spray should be in droplets 30 to 80 microns in diameter. For aerial application most of the droplets should be 70 to 100 microns in diameter if the areas are large and flat, and as large as 100 to 300 microns for the control of certain forest insects on rugged terrain.

The number of droplets of given size that would be deposited per unit area per gallon of liquid distributed on an acre of surface is presented. Smoke aerosols give a very low residual deposit.

Some factors affecting particle or droplet size are: type of distributing device, pressure, nozzle design, orifice size and shape, air velocity; spray concentration, density, type of insecticide, surface tension, viscosity of the mixture, rate of volatilization of the ingredients, distance to which the particles must be drifted, wind and other meteorological factors, volume and compactness of foliage, and settling rate.

NOZZLE DELIVERY AS RELATED TO ORIFICE TYPE

The data given in the text and tables that follow are from hundreds of tests and replicates and thousands of samples, and droplet measurements made in an intensive and extensive study of this subject during each of the past 10 years. The data and information presented are those of the author, except when indicated otherwise.

Table 3 lists the water output of cone and solid-stream nozzles for given orifice diameters and pressures. The proper use and setting of these nozzles will be given later under equipment construction and use. It is important to note that atomizing cone-type nozzles with 80° included angle only deliver 30 to 40 percent as much liquid as solid-stream orifices of the same diameter and pressure. The output decreases as the angle of spread is increased from 0 to 180 degrees. The flat or fan-type nozzles deliver theoretically the same output as the solid-stream orifices. Actually, most of them deliver about 10 percent less liquid than solid-stream orifices due to resistance from the restricting walls of the nozzle tip located just beyond the orifice. In general, rate of output increases or decreases as the square root of the pressure. For example, a given orifice delivered 5, 7.07, and 10 gallons per hour (g.p.h.) at 25, 50, and 100 pounds per square inch (p.s.i.).

Viscosity and surface tension are sometimes factors in the output of liquid as related to temperature. For example, at room temperature the output of five direct pressure nozzles ranged from 5 to 12 percent greater than for water when applying kerosene and oils of 30 to 35 seconds Saybolt viscosity. At 40 seconds viscosity, the flow of the water and oils was equal. At 50 seconds viscosity, the rate of flow of oils was 85 percent as fast as for water, and at 100 seconds viscosity the oils would not flow properly through orifices smaller than $^{3}/_{32}$ inch.

However, when made up as 25 percent oil emulsions, oils of 100 to 200 seconds viscosity flowed at about the same rate as water. At temperatures of 30°F. or lower, oils of 60 seconds viscosity or greater would not flow properly through nozzles.

TABLE 3. – OUTPUT OF CONE AND SOLID STREAM TYPE NOZZLES FOR GIVEN ORIFICE DIAMETERS AND PRESSURES

Orifice diameter, in hundredths of an inch	Output as a solid stream at 50 p.s.i.	Output as 70 to 80° cone [a] spray at:[b]		
		25 p. s. i.	50 p. s. i.	100 p. s. i.
	Gallons per hour			
1	1.1	—	—	0.5
2	4.4	1.0	1.45	2.1
3	9.9	2.3	3.24	4.6
4	17.6	4.1	5.76	8.1
5	27.5	6.3	9.0	12.6
6	40.0	9.1	13.0	18.3
7	54.0	12.6	18.0	25.3
7.8	66.0	15.4	22.0	30.8
8	70.4	16.1	23.0	32.2
9	89.1	20.5	29.3	42.0
10	110.0	25.3	36.3	51.8
12.5	172.0	39.2	56.0	78.5
15	248.0	57.0	81.0	114.0
17.5	337.00	77.0	110.0	154.0
20	464.0	101.0	144.0	202.0
25	688.0	158.0	225.0	315.0
37.5	1 547.0	355.0	506.0	709.0
50	2 750.0	630.0	900.0	1 260.0

[a] At outputs below 3 gallons per hour (g.p.h.) the included angle was less than 80 degrees, depending somewhat on pressure.

[b] Divide by 60 to find the gallons per minute (g.p.m.).

ANALYSIS OF MIST BLOWER APPLICATION

To obtain maximum efficiency of pest control while maintaining the greatest degree of safety for plants requires optimum drop size and velocity for best coverage and deposition on leaves, needles, twigs, and insects at given distances vertically or horizontally from the blower. The penetration and coverage of dense foliage requires a smaller particle size and greater air velocity than for sparse foliage and dormant trees. As the size of the particles decreases there is a corresponding need for increasing the air velocity in order to impinge the droplets. Solution for this problem is made more difficult by the fact that air velocity decreases as distance from the blower increases, which creates the need for increasing particle size with increase in distance from the blower in order to effect impingement of the drops. Insofar as is practical, formulations should be used that do not volatilize rapidly and thereby reduce the particle size in the air.

Two sets of figures were developed in an endeavor to determine the optimum drop size. One set of figures are theoretical calculations based on Sell's (1931) studies of the deposition of particles in a moving air stream and on Stoke's law (Miller, 1935) showing that particles fall with a velocity depending on their diameter or surface area and specific gravity. The other figures are from practical field tests.

Sell's formula for calculating the minimum air velocity for maximum deposit is as follows:

$$V_1 = \frac{20{,}000\ S}{D^2} \quad \text{where,}$$

V_1 = minimum velocity for maximum deposit in m. p. h.
S = width of object in inches
D = diameter of particles in microns

The upward air velocity required to overcome rate of fall can be computed from the formula:

$$V_2 = 0.0000605\ D^2 \quad \text{where,}$$

V_2 = Velocity of air in m.p.h. to overcome gravity oil spray weighing 7.8 lb. per gal.
D = diameter of particles in microns.

Increasing or decreasing the specific gravity of the spray solution directly increases or decreases the air velocity required to overcome the gravity of drops.

TABLE 4. – AIR VELOCITY REQUIRED TO OVERCOME GRAVITY OF DROPS HAVING A SPECIFIC GRAVITY OF 1.00, APPLICABLE TO VERTICAL PROJECTION

Diameter, of drops in microns	12.5	25	50	75	100	125	150	175	200	300
Velocity V_2 of air to overcome gravity, in m.p.h.	0.01	0.044	0.018	0.38	0.67	1.06	1.51	2.06	2.7	6.0

The minimum air velocity (V_1) required for deposition varies inversely with the drop size and the air velocity (V_2) required to overcome gravity. When these two are added the theoretical optimum drop size can be found for objects of various size.

TABLE 5. – MINIMUM AIR VELOCITY FOR EFFICIENT DEPOSITION WITH ELEVATION FOR DROPLETS AND OBJECTS OF VARIOUS SIZE

Width of objects, in inches	Particle size, in microns diameter								
	25μ	50μ	75μ	100μ	125μ	150μ	175μ	200μ	300μ
	Miles per hour								
½	4	1.2	0.7	0.8	1.0	1.4	1.6	1.8	5.5
¼	8	2.2	1.2	1.1	1.3	1.6	2.0	2.5	5.7
½	16	4.2	2.1	1.6	1.6	1.8	2.2	2.7	5.8
1	32	8.2	3.9	2.6	2.2	2.3	2.5	2.9	5.9
2	64	16.2	7.5	4.6	3.5	3.1	3.2	3.4	6.0
3	96	24.2	11.0	6.6	4.8	4.0	3.8	3.9	6.1
4	128	32.2	14.6	8.6	6.0	4.9	4.6	4.4	6.2
8	256	64.2	28.0	16.0	11.0	8.0	7.4	5.4	6.3

Ground Equipment

Mist blowers

The mist blower is the most interesting of the spray machines because it embodies the principles of all types of ground equipment and many of the principles of aircraft as well; they have a wider variety of uses and adaptations than other types. They have not had the volume of use enjoyed by the nonblower type low gallonage rigs, for only a small section of potential users are familiar with them.

The specific requirements and attachments for blower type applicators vary considerably with the kind of growth and size of areas to be treated. Table 6 indicates nine approximate sizes and capacities for general uses.

Fans and outlets

In mist blowers, the fan is the "heart" of the machine just as the pump is the "heart" of the hydraulic sprayer. Two methods of application characterize the use of fans as follows:

1. a high velocity of air at 185 to 300 m.p.h. to atomize and project the spray;
2. the use of a combination of medium high air velocity of 90 to 185 m.p.h. and hydraulic pressure nozzles or centrifugal spinner nozzles, to break up the spray and distribute it.

Table 6. – Horsepower, Weight, and Air Capacity of Mist Blowers

Horse power requirement	Weight, in pounds	Air velocity, in miles per hour	Air volume (cu. ft. per min.)	Preferred mounting
1.5 to 2	90–100	225	150	Wheelbarrow pick-up truck, trailer, small tractor
4 to 5	300	180	800	Trailer, truck, tractor
7	500 and 200[a]	175	1 700	Trailer, truck, big tractor
12	600 and 300	145	3 600	Trailer, truck, tractor
15	700	145	4 000	Truck, trailer, big tractor
25 to 30	1 800 to 2 000	135	8 000	Truck, tractor-drawn trailer
40 to 50	3 000	125	12 000 to 15 000	Truck, tractor-drawn trailer
25	2 000	80 to 100	19 000	Truck, tractor-drawn trailer
75[b]	4 000 to 5 000	120	24 000 to 30 000	Tractor-drawn trailer

[a] Weight of 200-300 lb. refers to use with light two-cycle engine.
[b] For discharging from both sides of machines.

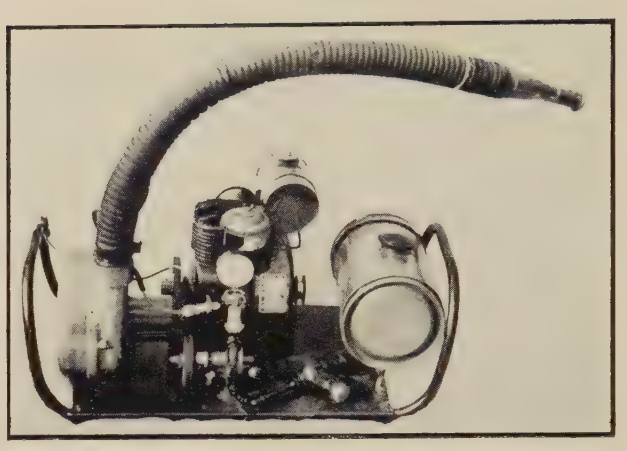


Figure 2. – *Skid model mist blower weighing 90 pounds, empty, to mount on a cart, tractor or truck for treating small trees and brush up to 30 feet in height.*
Courtesy, Connecticut Agr. Expt. Stn., New Haven, U.S.A.

There are two general types of fans, the axial flow and the centrifugal. So-called curved blade, squirrel cage or multivane, Soroceo, and multiple stage fans are merely modifications of these two types. No specific type of fan is best for all conditions, for a given fan may influence the design of a machine favorably for some jobs and unfavorably for others.

Belt drives, and some direct drives, have been successful. Weakly constructed right angle gear drives always break down. However, a strong, specially constructed right angle drive can be made to work on a strong, steady frame. Fans should be steady and as free of noise as possible.

The principal factors determining the type of fan to use are the air velocity required to break up and deposit the spray, the size of the machine, and whether the outfit is to be operated by one man or two men. In general, very small rigs (Figures 2 and 3) utilize high velocity air to break up the spray by shearing action. Hence, they may use high velocity, low volume, single or double stage fans. Usually the medium to medium-large rigs employ a combination of air velocity of 125 to 150 m.p.h. and hydraulic pressure of 150 p.s.i. or less, through whirl nozzles to atomize the spray. Machines of this type usually have delivered about 4,000 to 10,000 cubic feet per minute (c.f.m.) of air by either of the two types of fans. (Figures 5 and 6).

Machines of very high volume and low velocity may require a small, high velocity, low volume auxiliary blower to break up the spray and distribute it into the air stream from a big fan or they may atomize the spray with whirl or fan type nozzles at 200 to 600 p.s.i. For most forest and shade tree work, air velocities of 120 to 150 m.p.h. are required in volumes of at least 8,000 c.f.m. Volumes of 12,000 to 15,000 c.f.m. at velocities of 120 to 135 m.p.h. are preferred, or 18,000 to 26,000 c.f.m. of air at 95 to 115 m.p.h., for 70- to 120-foot trees, especially where elm bark beetles and certain other pests in the tops of the trees are to be controlled.

There is an optimum ratio between velocity and

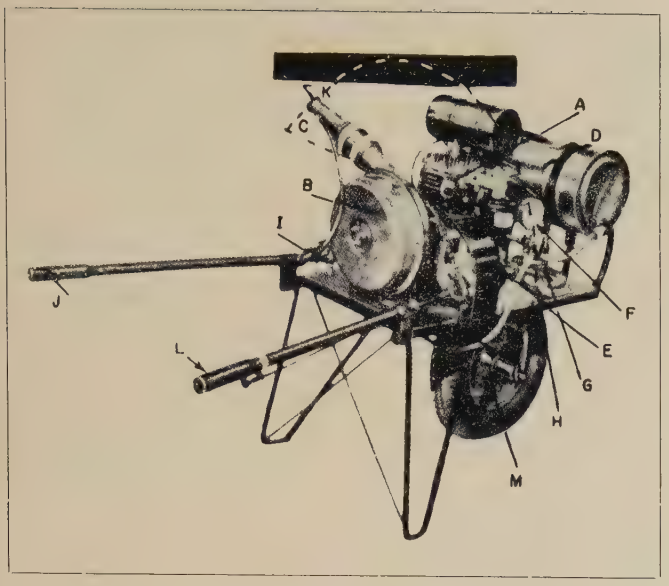


FIGURE 3. – *Wheelbarrow mist blower. The 1.5 h.p. engine* (A) *drives the high pressure blower* (B), *with a capacity of 120 cubic feet of air per minute, at approximately 240 M.p.h. velocity as it leaves the 1 1/4 inch diameter nozzle* (C). *Concentrate in the 3-gallon tank* (D) *is kept in suspension by agitation provided by an extra line from the pump. Pressure is maintained by pump* (E), *the belt is driven from the engine, and shown by gauge* (F), *and regulated at valve* (G) *at about 5 pounds. Clear lines are assured by strainer* (H) *between the tank and the pump. All hose is of neoprene rubber, resistant to oil concentrates. From the pump the concentrate goes through the "on-and-off" valve* (I), *controlled by twisting left handlebar grip* (J) *and continues to the end of the nozzle. It enters the hollow circular tip of nozzle* (K), *which has four outlets with 1/16 inch holes projecting into the airstream from the blower. This high velocity airstream atomizes the concentrate and carries the mist in whatever direction the nozzle is pointed. The up-and-down direction of the nozzle is controlled by twisting the grip* (L) *on the right handlebar. It travels in a 200° arc, and so can spray on either side. Moving the sprayer to the next spot is almost effortless, as the 140 pounds is so carefully balanced on the large 16-inch high wheel, with its 4-inch pneumatic tire. Thus one man can handle the entire spraying operation.*

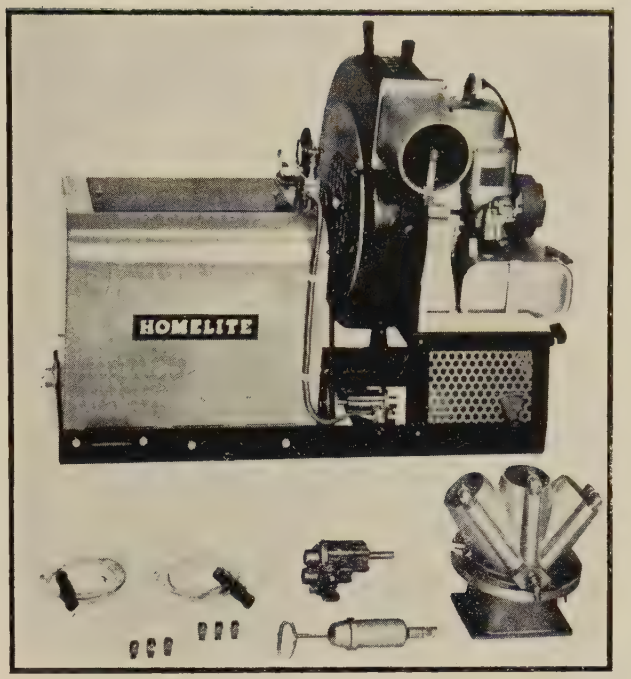


FIGURE 4. – *A 6-horsepower mist blower with a single 5-inch diameter outlet, nozzles, pump and triple-hole outlet.*

TABLE 7. – OPTIMUM VELOCITY AND VOLUME FOR ROUND OUTLETS OF GIVEN DIAMETER FOR TREE APPLICATION.[a]

Diameter of outlet, inches	Optimum velocity m.p.h.	Volume c. f. m.
4	170	1 300
8	150	4 200
10	145	6 300
10.5	140	6 300
12	130	8 000
15	126	—[b]
18	123	—[b]
20	120	21 000
24	115	27 000 (approx.)

[a] This is orifice velocity. Deposition velocity is much less.
[b] Figures not available.

volume at the orifice to attain the greatest height and distance with a given horse power under operating field conditions. The volume of air delivered is directly proportional to the square of the diameter of the outlet. Thus, a 24-inch outlet delivers four times as much air as one 12 inches in diameter at the same velocity. In shade tree work the optimum velocities for various sized outlets are given in Table 7. The figures in Table 7 do not correspond exactly to those of Table 6, due primarily to a slight difference in outlet size, nor do the figures correspond with those of Table 8, since Table 8 represents the actual machine in use while Table 7 represents the optimum conditions.

In small machines like the wheelbarrow model, a much higher air velocity (200 to 300 m.p.h.) has been employed because air velocity provides the means of atomizing the spray (Figure 3).

In the large machines spray delivery should be calibrated to permit regulation of any specified delivery between 20 and 180 gallons per hour (⅓ to 3 gallons per minute) (Figures 6, 7 and 8).

The size, shape, and flexibility of the outlet are important. For the small machines that deliver high velocities a very flexible outlet is essential to obtain even coverage. The round short outlet is the most efficient shape for shade tree and mosquito work where the fine spray must be driven to great distances. For the large, one-man operated orchard machines some air and power efficiency must be sacrificed in order to effect sufficient spread close to the machine. This spread may be obtained with slot or fishtail outlets with spreader vanes or spoilers, or with multiple round ones.

FIGURE 5. – *Treating six 30-inch rows of nursery stock with a mist blower mounted 4 feet above ground on a small tractor.*

Air speed at given distances from a fan depends on eight factors as follows:

1. air velocity;
2. air volume;
3. diameter of round outlet, width of fish tail, or slot outlets;
4. shape of outlet and angle of spreader deflectors;
5. the temperature of the air, moisture, content and weight;
6. upward or downward air currents;
7. wind velocity and direction in relation to direction of discharge from blower;
8. rate of travel of machine: travel reduces distance and air speed: two m.p.h. travel is equivalent to a 5-mile wind.

FIGURE 6. – *A 30-horsepower mist blower mounted on a turntable for treating tall trees.*

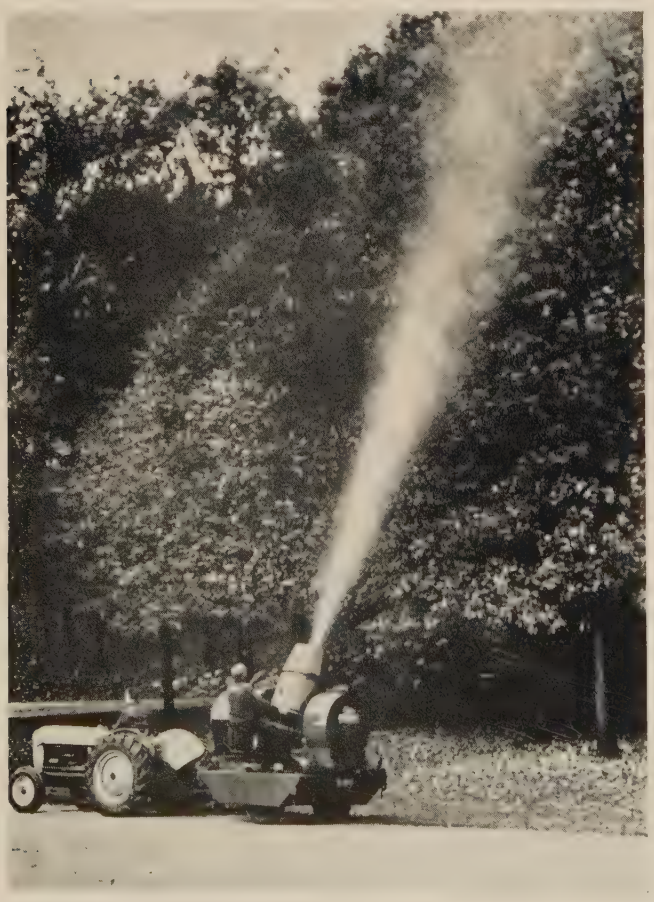


TABLE 8. – VARIATIONS IN SPRAY DELIVERY FOR THE DIFFERENT SIZED AIR OUTLETS

Outlet diameter, inches	Spray delivery, gallons per hour	
	Range	Efficient for most purposes
1.25	5 – 15	7
2	10 – 25	14
4	15 – 40	20
10	20 – 72	40
12	25 – 120	50
15	30 – 150	60
18	35 – 168	70
20	40 – 180	80
24	45 – 180	90

The flexibility of the outlet may determine the type of fan to use for highest operational efficiency. For example, certain axial flow fans are more efficient in moving air straight away from the fan than the paddle or centrifugal type fans. However, to use axial flow fans in forest and shade tree work, it is necessary to expend some horse power in forcing a direction change in the air stream, if the fan and outlet cannot be rotated

together. On the other hand, some of the paddle or centrifugal fan cases with straight short outlets can be rotated or easily swung up and down in a 180 to 230 degree arc with no loss of air efficiency. This operation, and a 180 degree (half turn) turntable is sufficient to take care of the others. This provision also permits making the rig shorter, more flexible, simpler, and more efficient in operation.

TABLE 9. – AIR VELOCITIES AT GIVEN HORIZONTAL DISTANCES FROM BLOWERS, DELIVERY THROUGH ROUND OUTLETS OF GIVEN DIAMETER [a]

Diameter of outlet (inches)	Approximate volume (c.f.m.)	Velocity (m. p. h.) at the following distances from blower							
		At blower outlet	10 feet	25 feet	50 feet	75 feet	100 feet	150 feet	200 feet
1	140	300	15	2	0	0			
1.25	200	225	20	3	0				
2	370	200	30	5	1	0			
4	1 300	170	40	8	2	0.2	0		
8	3 800	125	40	10	3	1	0		
10	6 100	140	70	35	6	3	1.8	0	
10.5	6 300	140	75	40	7	3	2	0–1	
12	7 500	125	60	30	7	4	2.5	1	0
24	20 000	90	50	25	7	6	4	2	0
24	28 000	120	75	40	17	10	9	7	3
54[b]	27 000	50	35	30	8	4	3	2	0

[a] Air gauges used were: 1. a gauge for measuring air velocity in terms of inches of water pressure, 2. an airplane pressure gauge, 3. low velocity gauge, and 4. an anemometer.

[b] Not an enclosure outlet.

FIGURE 7. – *A 25-horsepower blower-atomizer treating an 80-foot red oak at Yale Bowl, New Haven, Connecticut. The machines was equipped to apply dust, aerosol, spray-dust, and atomized concentrates. The nozzle assembly is such as to fill the air stream. The large outlet and velocity control makes possible a wide spray stream. A small amount of dust was added to facilitate photographing.*

Pumps

There are three general kinds of liquid pumps and diaphragm pumps which may be used: plunger, centrifugal, and gear. Plunger and diaphragm pumps can deliver any kind of mixture at any pressure. They are heavier and more expensive, but if kept in repair are more durable than gear types. Metal centrifugal pumps can deliver any kind of mixture at low pressures (below 40 p.s.i.). Spur-type gear pumps can deliver up to 150 pounds pressure at 1,200 to 2,000 r.p.m. (revolutions per minute). Ordinarily, abrasives like sulphur and cryolite will wear off the gears at such high speeds and pressures that present types of gear pumps do not last long when applying such abrasive substances at high speeds with pressures above 15 to 20 pounds. However, at pressures of 2 to 15 pounds and at speeds of 350 to 700 r.p.m., good ones may last one to three years. They are usually more satisfactory than centrifugal pumps for most mist blowers. For the small machines a 1/4 inch gear pump is adequate; however,

FIGURE 8. – *A truck-mounted mist blower treating an 70-foot elm tree in the dormant season.*

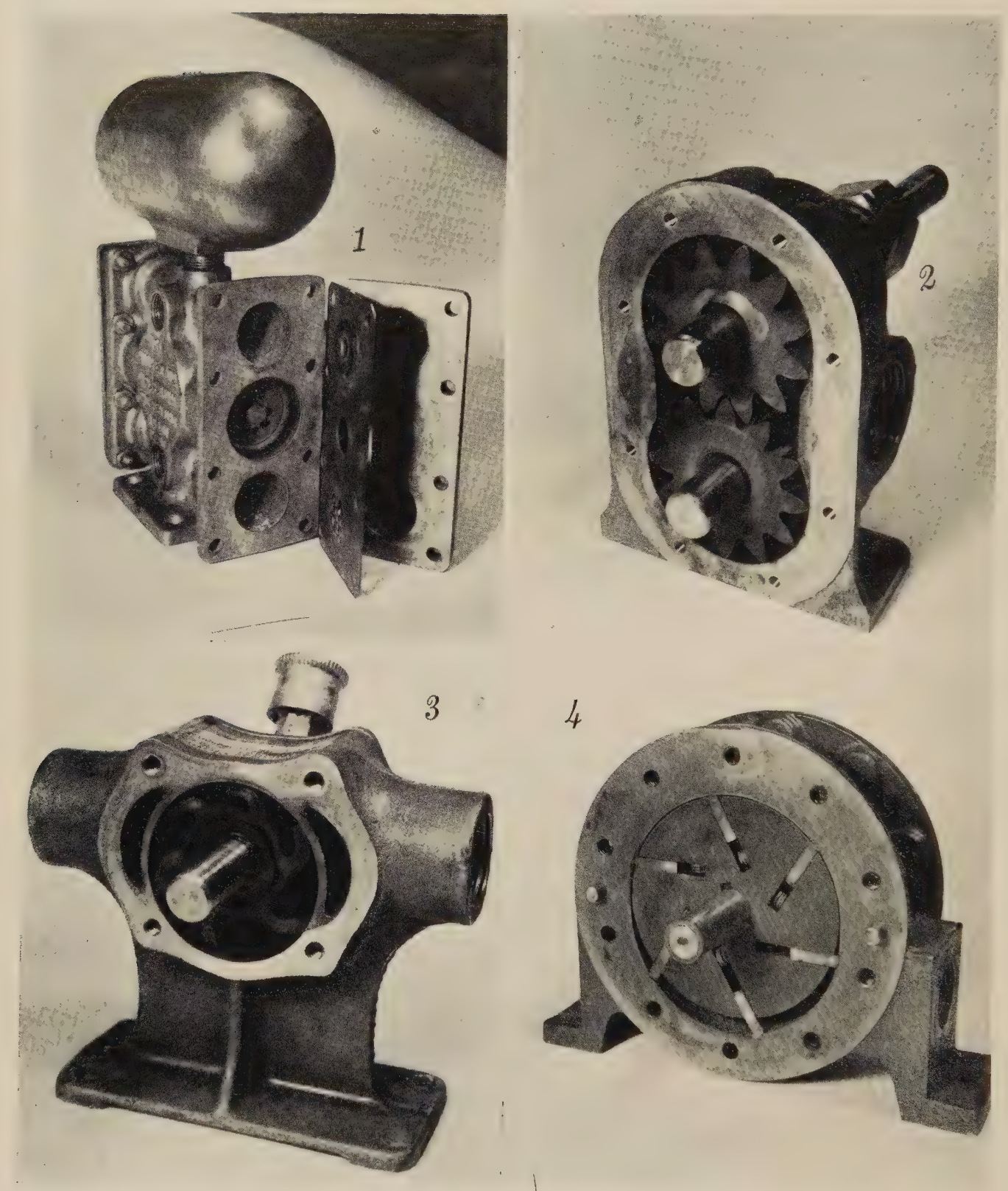


FIGURE 9. – *Four types of pumps.*

large rigs may require a 3/8 inch or 3/4 inch gear, or a 2- to 4-gallon-per-minute plunger pump (Figure 10).

The pumping systems require oiling, suitable liquid by-pass arrangements, relief valves, and pressure gauges with diaphragms to keep the liquid from entering the gauges. Gear pumps without " built in " pressure relief regulators are preferable for general use. To pump at specified low pressures, a suitable relief valve and large capacity by-pass are essential. Steady pressure without pulsations is essential in all spray systems.

Washers, gaskets and hose

All washers, gaskets, and hose must be resistant to oil solvents. Disintegrating rubber parts in the line can plague the operator continuously by repeatedly plugging the nozzles. Leather washers and neoprene hose (such as Weatherhead hose) and some plastics are more resistant than natural rubber products. It is expected that some of the new plastic materials may replace rubber materials.

Tanks and agitators

Supply tanks should be of the proper size and shape. This depends on the capacity of the machine and the nature of application. On big machines 40- to 75-gallon tanks are suitable for shade tree spraying, but 75- to 300-gallon tanks are desirable for fruit trees. A round or trough-shaped bottom with a mechanical agitator is desirable for mixing any kind of material, and for agitation. By-pass agitation is insufficient. Paddle type agitators should move slowly, sweep the bottom, and be provided with a disengaging mechanism. Spiral blade agitators may move faster. For filling purposes, tanks should have a wide mouth provided with 12- to 16-mesh removable strainer. It is helpful to have a quantity gauge for reading the volume of mixture in the tank. The tank metal should be noncorrosive, and any paints applied to it should be able to withstand oil solvents and ordinary spray chemicals.

The construction must enable the operator to drain the tank and spray line quickly and completely. Hence a large tank drain plug should be located conveniently. Sometimes it is handy to be able to connect a hose to the drain plug connection to convey the waste solution to a disposal spot. It is important to avoid strainer wells in the tank's bottom. It is also important to be able to shut off the tank from the spray line at a point immediately below the tank to prevent spray material from settling down into the spray line, strainers and nozzles.

Other construction details

Screw type valves should not be installed except for regulating pressure or liquid to be by-passed. A quick-acting shut-off valve operated by a foot or hand lever is absolutely essential. It must be conveniently located so that the operator can use both hands simultaneously for "finger touch" manipulation of outlet and liquid and dust shut-off levers. It should also permit him to observe the spray operation continually without changing his line of vision.

One large surface area strainer of approximately 16 mesh should be located between tank and pump. A 20-mesh strainer of smaller size should be placed in the line between pump and nozzles. All coarse mixtures prepared outside of the machine should be poured through a strainer in the top of the spray tank. Many modern spray materials of small particle size, however, do not require it.

Some means of measuring and regulating the quantity of spray material delivered per minute, per tree, per given area, or per given distance of travel is helpful. Hence, there is a definite need for at least one of three types of meters: a flow meter, a time (dial) meter, and a distance or low speed speedometer to measure rates of travel between 0 and 6 miles per hour.

The turntable may be power-driven by hydraulic motor or electric motor equipment with generator; or the machine may be turned by the operator pushing the unit around with his feet while in the seat of the machine, or with a wheel and cable. The latter is the cheapest and simplest method. The turntable should be provided with a good hand- or foot-brake.

In spraying forests for control of brush and hardwoods, 6 to 16 h.p. mist blowers are mounted on crawler type tractors. For shade tree and mosquito spraying, the machine is usually mounted on a truck with wide tires to reduce damage to lawns. For treating orchards, it is usually drawn on a trailer.

For night work a good spotlight can be mounted on the rotating outlet head or heads.

A throat microphone, or preferably a two-way chest microphone is useful for communication between operator and driver. The throat microphone costs less than 10 dollars, and consists of earphones, four 1½ volt dry batteries, a rubber covered, two-strand wire, and throat microphone.

Mist blower specifications for tall forest and shade trees

Air volume. 8,000 c.f.m. or greater, depending on velocity.

Air velocity. 125 m.p.h. or greater for air volume of 8,000 to 10,000 c.f.m.; or 90 to 110 m.p.h. for air volumes of 20,000 to 30,000 c.f.m.

Diameter of outlet. 12 inches or *greater*, depending on air volume.

Pump. To deliver at least 2 gallons per minute. A plunger pump or a diaphragm pump is satisfactory for all mixtures and is preferred where wettable powder suspensions are to be applied at high pressure. A gear pump is satisfactory if only solutions and emulsions are to be used. A ½- to 1-inch gear pump is acceptable for wettable powders if pressures less than 20 pounds are used provided the pump turns less than 750 r.p.m. to reduce abrasiveness.

Delivery regulation. 1/5 g.p.m. to 2 g.p.m. with or without metering device.

Engine. Usually over 20 h.p., depending on performance.

Tank. 40 gallons or greater capacity, with suitable drain plug, and coated with material that is resistant to rust, corrosion, acids, and solvents.

Agitator. Mechanical agitation is preferred, especially where suspensions are to be used.

Outlet rotation. 210° arc is sufficient. Easily rotated mechanically or by hand.

Turntable. Required with a brake and capable of making a 360 degree turn easily. Must be convenient for oiling, changing points, spark plugs, etc.

Shut-off valve. Quick-acting type, conveniently located to operator.

Turning diameter. Less than 9 feet.

Floor space. Less than 73 × 73 inches.

Weight. Less than 3,000 pounds.

Strainers. Suitable 16 to 20 mesh strainer for suspensions is necessary.

Atomization. Capable of producing mass average diameters between 35 and 80 microns diameter.

Construction. Sturdy, durable, simple, easily operated, adaptable, and easily repaired and transported.

Location of seat and operator. Must be remote from the heat of the the engine's exhaust and from leakage of air and spray material.

FIGURE 10. – *A 2-horsepower, 38-pound knapsack mist blower. In the picture the cushion for protecting the operator's back is lying flat against his back.*

Mounting. For available trucks or mounted on a trailer.

Performance. Must meet efficient performance requirements for the jobs intended in addition to the above specifications.

A sheet of instructions on methods of operation and maintenance must be supplied with the machine.

COMPRESSED AIR AND KNAPSACK SPRAYERS

Compressed air sprayers

These are so named because air is compressed in the tank above the liquid. The essential parts are a tank (usually cylindrical) for spray material, with carrying handle or shoulder strap, pressure-tight filler cap, air pump for compressing air in tank, discharge tube which conveys the liquid in the tank to the discharge system consisting of hose, extension spray tube, spray control valve, strainer and nozzle. They are cheaper, easier to clean, and more popular than the handle-operated diaphragm or piston pump knapsack sprayers. Compressed air sprayers are normally operated with 25 to 50 pounds air pressure on the liquid.

For special uses requiring a specified constant pressure, an auxiliary air tank is required with intake valve and a constant pressure regulator between the air tank and the liquid tank.

Some models have CO_2 gas cylinders to provide operating pressure. They discharge up to 15 gallons of material at uniform spraying pressure. Refilling cost is moderate. Use of the compressed gas permits utilizing the full capacity of the tank for spray material.

Knapsack sprayers

Knapsack sprayers, as the name implies, are carried on the back like a knapsack by means of two shoulder straps (Figures 10 and 11). The tank is shaped to fit the back, but is not always comfortable. Some makes have built-in liquid pumps of diaphragm or piston type which the operator pumps continuously while spraying. A pressure chamber reduces pulsations. Other models are provided with a double-acting external slidetype pump. Top pressures range from 80 pounds for the internal type pump to 175 pounds for the slide type pump. Operation of the pump provides a mild form of mechanical agitation that is not sufficient for wettable powder mixtures without occasional shaking. Pump handles may be attached at either side to permit right or left hand spraying.

Most knapsack sprayer tanks are made of galvanized steel but some models are available in copper or stainless steel at additional cost. Tank capacities range from 4 to 6 gallons.

The ordinary back, fire pumps are not suited for applying concentrated sprays.

The common faults of present-day compressed air and knapsack sprayers are listed below together with

FIGURE 11. – *A knapsack sprayer treating pine leaders with concentrated spray delivered through an atomizing nozzle.*

some suggested remedies for manufacturers and users of such equipment:

1. The hose is too short. A length of 4 to 5 feet is needed to provide reach and leverage.
2. Sore backs are often caused by poor back protection and leakage through the tops of knapsack sprayers. This is particularly serious when applying certain solvents and poisons. Proper back fits, padding, and tight covers would help.
3. Gaskets and plunger rubbers and packings are readily decomposed by solvents such as xylene, oils, and various other chemicals. Sprayers should be equipped with resistant materials.
4. Some sprayers do not discharge all of the mixture in the tank.
5. Most sprayers are not equipped with durable, dependable shut-off valves that do not leak.
6. Poor agitation.
7. The tanks tend to corrode and rust. This can be prevented by coating the inside of the tank with a protective material and by prompt cleaning and drying.
8. Extension rods longer than 3 feet are too heavy. A lightweight metal, such as magnesium, should be used. If it is still too heavy, the extension rod should be strapped on a bamboo pole or placed inside of it by running the rod through a hole drilled the length of the pole.

(To be concluded)

FIGURE 1. – *Wind erosion and moving sand dunes are serious problems in many parts of West Pakistan. The dunes not only put land out of cultivation but also affect adjoining productive land by covering it with sterile sand.*

Sand Dunes in West Pakistan

WORK on the stabilization of sand dunes started by the Pakistan Government in 1955 is beginning to yield encouraging results, especially with the type classified as "cold region sand dune," illustrated in these photographs, taken by the Central Soil Conservation Organization, Quetta, which is responsible for the conduct of research in this field.

The valley of Mastung, situated between Quetta and Kalat at an elevation of 6,000 feet (1,800 meters), has been selected for much of this work. The valley is famous for its irrigated crops of potatoes, onions, tobacco, spices, melons, vegetables, almonds, apricots, peaches, plums, grapes and apples. Since irrigation water is not adequate for the entire cultivable land, some of it must remain idle for as long as 4 or 5 years,

FIGURE 2. – *Sand dunes encroaching upon a wheat field. In the background is an orchard partly buried under dunes.*

FIGURE 3. – *Sand dunes encroaching upon tree-cover and habitations.*

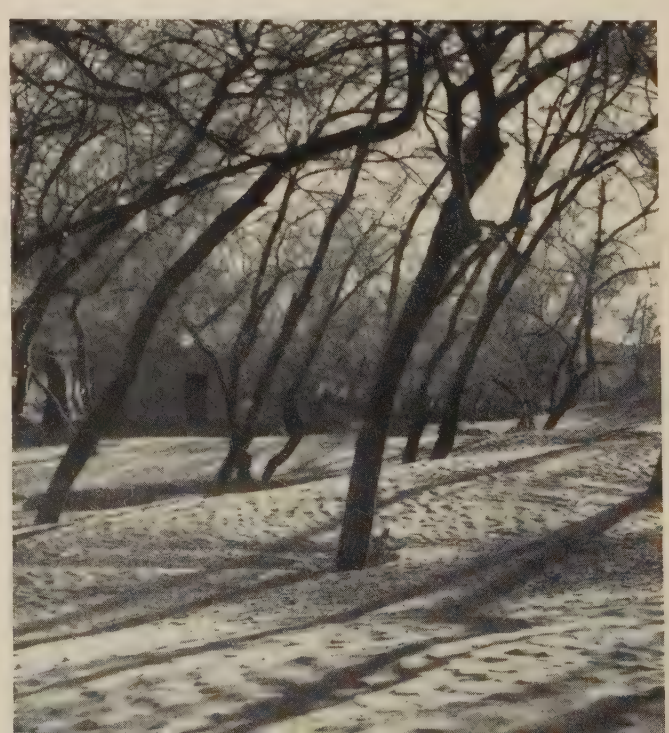


FIGURE 4. – *Plantation of* Arundo donax, Calligonum polygonoides *and* Tamarix gallica, *without irrigation, after one growing season.*

FIGURE 5. – *Reclaimed sand dunes. Two years' growth on right of track, one year's growth on left.*

during which time livestock is allowed to graze on the spontaneous weed-growth, and woody shrubs are uprooted to provide fuel, with the frequent result that the topsoil is exposed to wind erosion during the dry summer season. Over 10 square miles (26 square kilometers) of the valley's productive land has, in this manner, already been turned into unproductive mobile dunes, whose presence threatens roads and neighboring fields, and reduces yields by the abrasive action of the drifting sands. Research on methods of control and stabilization has resulted in an effective technique for raising wind-breaks and for dune fixation in the area without irrigation.

Rows of *Calligonum polygonoides* raised from seed, *Arundo donas* grown from closely spaced culms, and *Tamarix gallica*, whose branch-cuttings are set at 5 feet (1.5 meters) in and between rows, rapidly produce an effective, inexpensive wind-break. These are up to 8 rows in depth, and are spaced at a distance equivalent to ten times the height the shelterbelt is expected to attain. The interspaces are then sown with drought-resistant timber and forage trees, shrubs and grasses which thus contribute to the local economy and welfare.

FIGURE 6. – Tamarix *two years after planting, without irrigation. Raised from cuttings.*

FIGURE 7. – Robinia pseudoacacia *one year after unirrigated plantation, from nursery grown seedlings.*

FIGURE 8. – *Forage grasses are planted once the wind breaks are established. Here,* Arundo donax *protects a six-month old planting of* Agropyron desertorum *and* Boutelona *spp.*

FIGURE 9. – *Another fodder-grass,* Agropyron elongatum, *protected by* Arundo donax, *eighteen months after direct sowing.*

Technical Assistance Activities in India

Forestry practices are well developed in India and there is a long tradition of sound forest management: utilization methods and the development of forest industries, on the other hand, have tended to lag behind.

The authorities in India have recognized this situation in formulating their requests to FAO for technical aid over the past six years. These requests have tended to fall into three categories:

1. Filling gaps in the field of forest research, as agreed by the Dehra Dun Forest Research Institute. Missions have been concerned with establishing programs for the control of desert encroachment; soil conservation and watershed management; on forest influences (effects particularly on water flow and water supplies); and relating to genetics (forest tree improvement). The expert on forest influences research (B. Frank) is now in India, but the genetics expert will start his assignment towards the end of the year.
2. Improving the efficiency and lowering the cost of logging and timber extraction. Experts have been assigned to help create a mechanical logging branch at the Dehra Dun Institute, to advise on programs for promoting efficiency and research in timber harvesting, to institute training of forest workers, and advise on high mountain timber extraction. These efforts culminated in the organization in 1958 of a mobile logging and primary conversion demonstration center in mountain country. Further follow-up work has been planned to be carried out in 1960.
3. The development of forest industries and more intensive use of the available wood resources. In this field FAO has provided experts to advise on modern wood preservation practices and their application in industry; the protection of wood against marine borers; the creation of a timber engineering unit at Dehra Dun; and on improved resin tapping and manufacturing processes. Experts have advised on the development of sawmills in the Andamans, on the development of the plywood and tea chest manufacturing industry throughout India, and on a development plan for forest industries in Assam. A country-wide survey of pulp and paper development possibilities has been undertaken. Action to implement the recommendations made has been taken at the federal level, by the states, and by industries.

While these various activities have been going on, the Forest Department has undertaken a study of national forest resources and future wood requirements, in connection with the current FAO project to appraise the regional wood resources and requirements (Far East Timber Trends Study). The resultant analysis has given a clear picture of the resources available and what the consumption requirements are likely progressively to become.

The next stage is to draw up, in collaboration with the federal forest authority, the planning commission and appropriate ministries, and with the states, a plan for the integrated development of forest industries throughout the country for better and more economical use of the available resources and to provide new products to meet in the highest degree possible future requirements. For this purpose, an FAO expert (J. von Monroy) is assigned to India through 1959, to be joined later in the year by two short-term experts specialized in particular industries.

The plans and recommendations emerging from this mission, which will extend into 1960, will be incorporated into the next national five-year economic development plan. In due course, there will emerge from this plan the future shape of FAO technical assistance activities in India.

FAO/IUFRO Committee on Bibliography

In *Unasylva*, Volume 11, Number 3, 1957, in an article, "Forestry Bibliography," the method of procedure for the development of amendements to the Oxford System of Decimal Classification for Forestry (O.D.C.) was outlined and, in accordance with the ruling that any decisions taken in this matter would be notified in *Unasylva*, the first amendment, as authorized at the Joint Committee's Ninth Session at Oxford in July 1956, was published in the same issue.

The Joint Committee met again at Helsinki in May 1958, where further proposals were examined and discussed. As a result, notification is made of the following decisions:

Amendment No. 2., as authorized by the Joint FAO/IUFRO Committee on Bibliography (Helsinki, May, 1958)

161.4	*add*	, including growth regulators.
232.322.44	*add*	and household refuse.
232.322.49	*add*	, including soil conditioners, e.g. Krilium.

add 440	General matters. Predisposing factors and causes (including forecasting of outbreaks). [Cross-reference to other subdivisions of 44 as appropriate.]
525.5 *Interpolate*	Actual versus nominal outturn (including *Ernteverlust*). *between* Merchantable dimensions and volume... *and* Deductions for defect, etc.
add 560	General matters (including sampling methods in increment determination).

The German text of the amendment is being made available in the leading Austrian, German and Swiss forestry periodicals appearing at about this time.

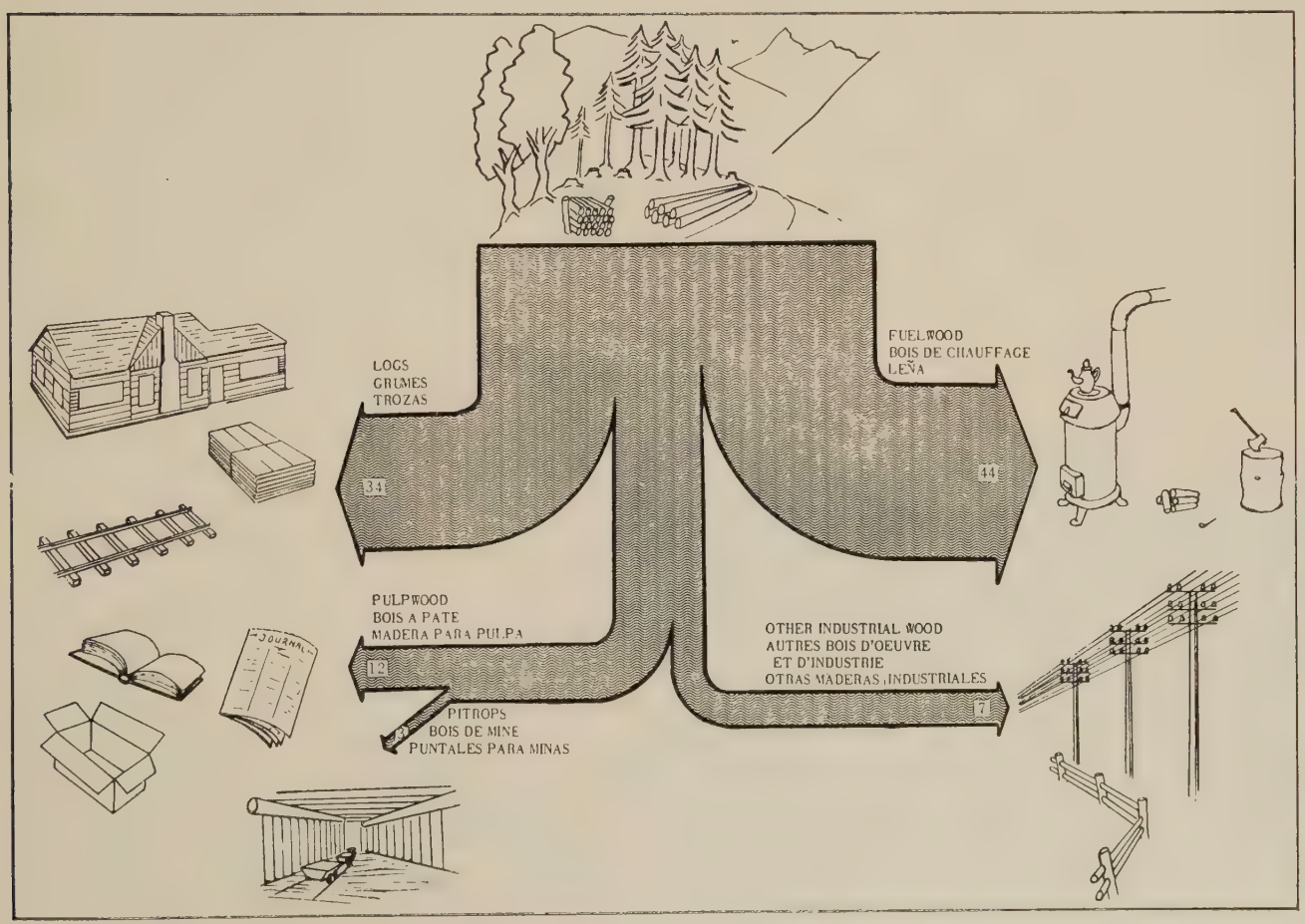
At the invitation of the Spanish-language representative on the Committee, Don Manuel Neira, who is Chairman of the Spanish Forestry Bibliography and Terminology Commission, the next meeting of the Joint Committee will be held in Madrid in September 1959. Any proposals for new or altered subheads, which should be submitted to the Joint Committee *via* the Commonwealth Forestry Bureau at Oxford, England, will be examined and discussed on that occasion.

Forest Workers

FAO was represented at the Tripartite Technical Meeting on the Timber Industry, organized by the International Labour Organisation at Geneva, 8 to 19 December 1958. The agenda of this meeting, the first called to deal with forest workers, covered the general field of operations carried out within or in the neighborhood of the forest area, accident prevention, conditions of work and workers' welfare in logging camps, and labor-management relations.

The Governing Body of the International Labour Organisation was invited to study means whereby greater stability of employment might be secured in forest industries; to continue co-operation with FAO and the Economic Commission for Europe on forest working techniques and vocational training; to improve safety in forest operations; and to co-operate with FAO and the World Health Organization in studying the food requirements of workers engaged in strenuous physical work in various climates. It was proposed that a new Industrial Committee be set up to deal with forest industries, particularly conditions of employment and living conditions.

A chart showing the utilization of roundwood removals, as percentages of the world total, in 1957.
Source, *FAO Yearbook of Forest Products Statistics, 1958.*



Equipment Section

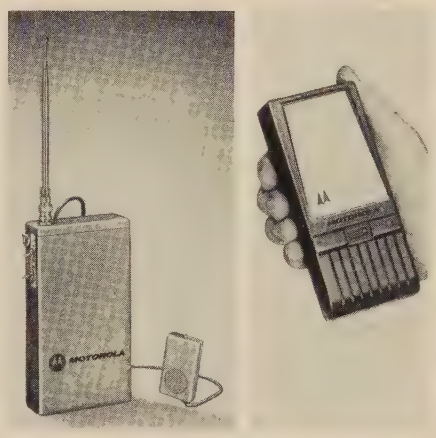
Prentice Hydraulic Loader. — Completely self-contained unit. Boom swing 300°. Power take-off pump provides power to lift 3,000 lb. (1,360 kg.), or approx. ¼ cord of pulpwood. Readily installed on any standard truck. Approx. 8 ft. (2.6 m.) of loading space. In transit weight of boom and bucket can be transferred to front axle. Removable without excessive expense or loss of time.

Heikkinen Machine Co., Prentice, Wisconsin, U.S.A.

Motorola Handie-talkie Pocket Receiver and Transmitter. — Pocket transmitter together with the pocket receiver provides full 2-way radio communications to man engaged in construction work, mining, forestry, agriculture, etc. Weight, 46 oz. (1.3 kg.); measures approx. 8 × 4 × 1½ in. (20 × 10 × 4 cm.). Provides full 1 ¼ watt radio frequency in the 25-54 Mc band and 1.0 watt in the 144-174 Mc band.

Pocket receiver operates from easily charged mercury cells or nickel-cadmium batteries. Weight, 10 ½-12 oz. (300 to 340 g.), depending on the type of battery used. Length, 6 in. (15 cm.), width, 2 ½ in. (6.4 cm.), depth, 1 1/8 in. (3 cm.). Receiver clips onto user's belt or fits into pocket.

Motorola Inc. 4501, West Augusta Boulevard, Chicago 51, Illinois, U.S.A.



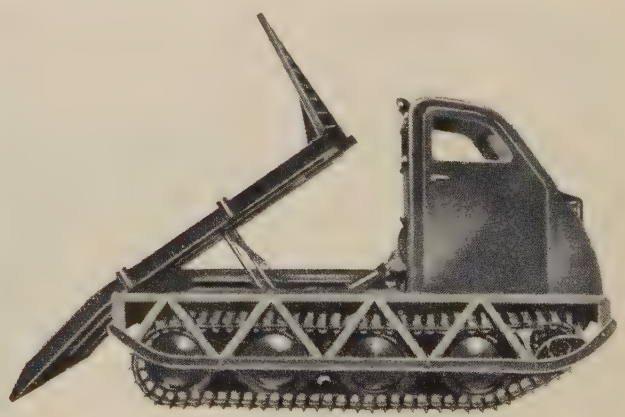
Grenmulder. — Crushes twigs and branches, operates close to trunks with its whole width extending to one side of the tractor without dragging on the tractor road wheels.

Manufactured in following widths: 69 in. (175 cm.) and 63 in. (160 cm.) and the working depth is 4-5 in. (10-12 cm.) depending on the character of the soil. Cuts branches of 1 ½ to 2 in. (4 to 5 cm.) diam. Drawn by medium-size tractor operated by tractor driver. Closed ball bearings require lubrication only once a year.

Abildgaardens Frugtplantager, Bistrup pr. Birkerød, Denmark.

Bombardier Muskeg Tractor - Model H. D. W. — *Specifications*: Overall length, 15 ft. 3 in. (4.6 m.); width, 7 ft. 3 in. (2.2 m.); height, 7 ft. 4 in. (2.2 m.); platform length 10 ft. (3 m.). Max. speed 16 mph (25.7 km/h); payload capacity (max.) 6,000 lb. (2,720 kg.); turning radius 15 ft. (4.6 m.). Chrysler engine 6 cylinders; brake horse power 115 at 3,400 rpm. Track type-rubber belts with steel cross links. Track width 28 in. (71 cm.). Control — hydraulic through cylinders. Winch 3 speeds fwd, 1 rev.; control - inside operator's cab powered through transfer case. Cable drum 9 in. (23 cm.) diameter by 13 ½ in. (34 cm.) long. Cable drum flange 15 ½ in. (39 cm.).

Bombardier Snowmobile Limited, Valcourt, Quebec, Canada.



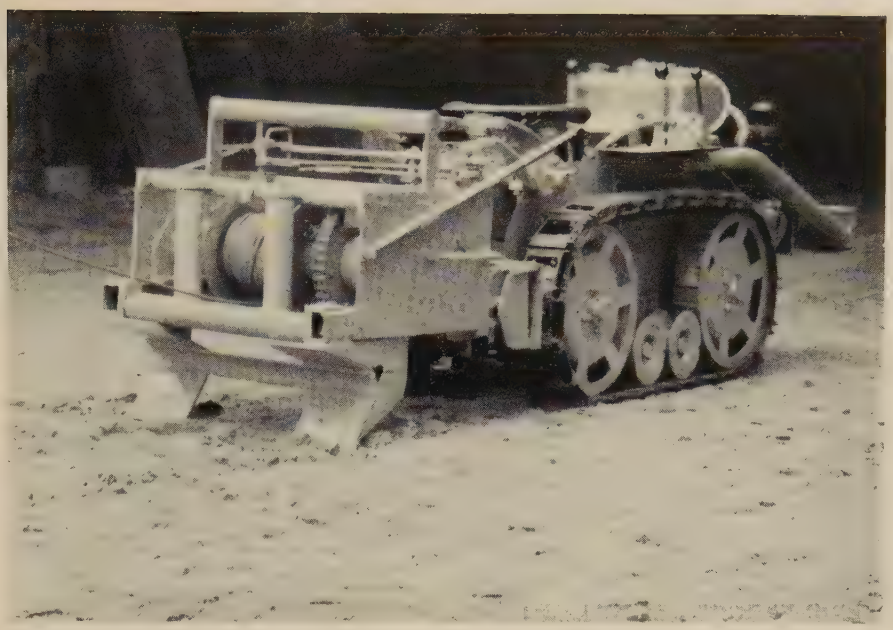
Taskers 12-Ton Rear Steering Semi-trailer. — Designed so that rear wheels automatically steered by turning movement of prime mover. They follow in tracks of prime mover at all angles of turn.

Steering mechanism incorporated entirely in the semi-trailer operated by coupling which accepts the standard SAE/SMMT fifth wheel pin. No modification whatsoever of prime mover or fifth wheel required. Connecting rods transmit movement to turntable of *nearside* wheel assembly and thence to the *offside* assembly of track rod.

The body is a flat platform 24 ft. (7.3 m.) long by 7 ft. 2 in. (2.2 m.) wide with raised rave.

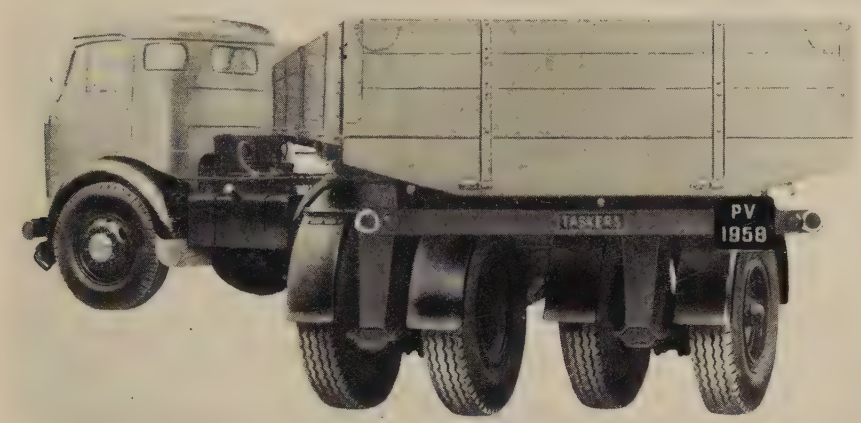
Approx. weights: Trailer chassis 24 ft. (7.3 m.), 2 tons 16 cwt. (2,845 kg.); with platform body 24 ft. (7.3 m.) 3 tons 3 cwt. 2 qrs. (3,225 kg.).

Taskers of Andover (1932) Ltd., Waterloo Iron Works, Andover, Hants, England.



Unirag Tractor. — *Specifications*: Engine 12 hp diesel. Speeds - 3 fwd. 1.5 km/h., 3.5 km/h. and 6.0 km/h.; 1 rev. 1.0 km/h. Weight, approx. 800 kg., length, 2,000 mm.; width, 700 mm; tread, 580 mm.; height, 1,100 mm. Winch cable length up to 150 m.; maximum pull, 3,500 kg.

EIMEHA Herbert Bohschke K.G., Düsseldorf, Germany.



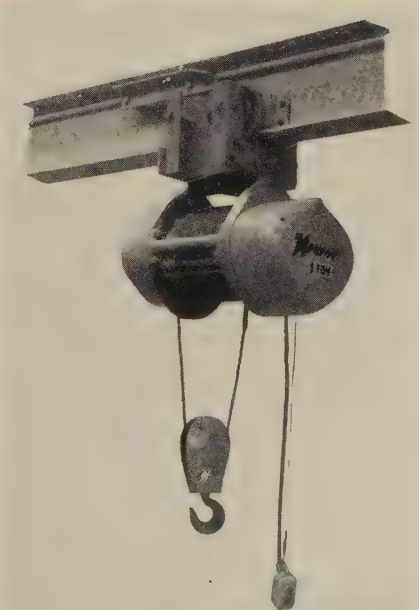
Jet-Dozer Log Pond Boat. — Steel boat specially built for sorting and moving individual logs or bundles in mill ponds, dumps and booming grounds. Jet-propelled. Propulsion unit is special centrifugal pump, exhausting water through the movable jet or nozzle. Steering wheel steers boat by controlling direction of jet. Power plant is 85 hp, 6 cylinder Chrysler engine, water-cooled.

Specifications: Length, 15 ft. (4.6 m.); beam, 6 ft. 6 in. (2 m.); draft, 18 in. (46 cm.) approx.; sides at bow and stern, ¼ in. pl. (6 mm.); bottom 3/16 in. (5 mm.); deck 1/8 in. (3 mm.).

John Manly Ltd., Ft. of 20th Street, New Westminster B.C., Canada.

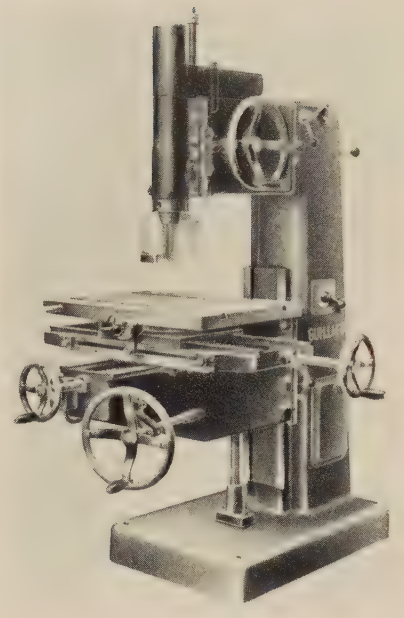
M 101 Electric Hoist. — Block in fixed suspension or pedestal mounting form lifts 10 cwt. or 1 ton through 23 or 43 ft. (7 or 13 m.) at 20 ft. (6 m.) per minute. Ball and roller bearing, or oil bath lubricated gears and steel frame. If the hoist is to travel on a runway, a range of trolleys is available in push hand geared and electric travelling form. Trolleys adjustable on installation to suit any beam from 4 to 6 in. (10 to 15 cm.) wide. A 1 ½ squirrel cage, totally enclosed, electric motor running at 1,440 rpm, supported at both ends inside hoist barrel. Travelling speed 50 to 100 ft. (15 to 30 m.) per minute. Unless otherwise specified, the unit will be for 400/440 Volts, 3 phase, 50 cycles.

Matterson Limited, P.O. Box 31, Rochdale, England.



ILO Car Shunter — A powerful means of moving railroad cars with max. total weight of 100 tons at speeds up to normal walking speeds. Can be freely moved anywhere in yard. Climbs easily over rails and obstructions. One man operating the Shunter can move cars, either separately or in groups, or disperse or make up complete trains. *Specifications*: Conventional, quick-starting one cylinder gas engine, two cycle, uses commercial gasoline, mixed 20 to 1 with oil for self-lubrication. Output 6 hp. at 3,000 rpm.; gravity center of its 550 lb. (250 kg.) under axle for easy manoeuvering; simple controls with 3 fwd. speeds.

ILO Werke G.m.b.H., Pinneberg/ Hamburg, Germany.



Router Milling Machine with Tilting Head — EYH Model. — Equipped with enclosed, 2-way rotating, 2-speed motor. Spindle speeds: 2,100, 3,000, 4,200 and 6,000 rpm. Motor, 1.75 hp. at 1,500 rpm.; 2.5 hp at 3,000 rpm. Spindle head rotates at 160° on plane perpendicular to axis of arm. Vertical travel of spindle, 120 mm. Table dimensions, 700 × 500 mm. Distance between axis of spindle and support, 500 mm. Vertical travel of table, 380 mm. Lengthwise horizontal travel of table, 550 mm. Transversal horizontal travel of table, 400 mm. (approx. 16 in.). Net weight approx. 700 kg.

Guilliet, Auxerre, France.

Motorized Dust Gun. — Provides penetrating cloud of insecticide and fungicide in powder form for control of all pests and diseases. Suitable for use on practically every type of crop.

Drake and Fletcher Ltd., Maidstone, Kent, England.

Portable Metal Detector Cintel. — Comprises flat search head, approx. 11 in. (28 cm.) long × 7 in. (18 cm.) wide × 1 ½ in. (4 cm.) thick. Short carrying handle attached, inside which are complete transistorized amplifier and batteries. A pair of lightweight headphones completes the equipment. With the search head held away from all sources of metal, a single control is turned until note just ceases to be heard in headphones. If head is then brought into vicinity of any metal, a loud note will be heard in the headphones.

Rank Cintel Limited, Worsley Bridge Road, Lower Sydenham, London.

Shawnee Log Grapple. — Side mounted on tractor, leaving the rear end free for mounting other equipment, if desired. Works over front of tractor, operator in normal driving position. Finger tip control on all operations. Placement of load on truck without moving tractor.

Shawnee Manufacturing Co., Inc., 1947, North Topeka Avenue, Topeka, Kansas, U.S.A.

Correction

Volume 12, Number 3, page 146

Footage counters for woodworking machinery.

The last sentence should read: "Photograph shows *sawbench measuring unit.*" instead of "*edger unit for attachment to straight line edgers*".

News of the World

Argentina

• The government-operated railroad company in Argentina is reported to have signed a five year contract with a local firm at Santiago del Estero for preservative treatment of 2.5 million wooden sleepers of quebracho blanco (*Aspidosperma quebracho-blanco*) at an approximate cost of U.S. 22 cents each. Quebracho blanco is a tree that occurs in the Chaco forest area extending from Santa Cruz (Bolivia) to Matto Grosso (Brazil), western Paraguay and north central Argentina. Its physical properties make it very suitable for use as railway sleepers (crossties) once the wood has received preservative treatment. Mr. C. E. Elliot, Deputy Director of the Forest Products Division, Australian Commonwealth Scientific and Industrial Research Organization, while serving recently on an FAO technical assistance mission on wood utilization in Argentina, emphasized the value of using treated quebracho blanco for sleepers as a means of making wider use of indigenous timber species.

Burma

• The first plywood plant to be set up in Burma has gone into production. The plant, which was imported from Japan, has been established by a leading Burmese timber operator. Its present production is 850 sheets of plywood, 4 feet × 8 feet, per day with unskilled labor. As this labor becomes more skilled, it is anticipated that daily output will be considerably increased. A contract has already been made for the supply of 50,000 sheets of plywood, valued at kyats 10 lakhs (U.S. $21,000), to a West German firm.

The introduction of plywood plants in Burma, as well as other new forest utilization industries, was recommended by FAO expert, J. A. von Monroy, who carried out an assignment some years ago to advise on the development of integrated forest industries in Burma.

Canada

• The Canadian forest industries, an official report to FAO states, experienced in 1957 their first major set-back since the close of the second World war. A record total utilization in 1956 of almost 3,500 million cubic feet, representing an increase of 5 percent over the previous year, was followed by a sharp drop in output during the latter half of 1957, when a general recession in business activity affected the forest industries to a varying degree in all sectors.

The general decline in building construction in Canada and the United States resulted in a reduced demand for Canadian lumber, production for 1957 being 12 percent lower than in 1956 and 14 percent below the 1955 figure. Lumber exports also declined almost 8 percent from the 3,900 million board feet exported in 1956. It should be pointed out, however, that exports to the United Kingdom increased by 5 percent over the previous year.

Although the production of softwood plywood in 1957 did not show an increase, the influx of Japanese plywood into North America caused an unfavorable reaction in Canada's hardwood plywood industry, indicated by a 14 percent reduction in the output of birch plywood. Poplar plywood, on the other hand, continued to expand its capacity, and production for 1957 rose by 12 percent.

An increase in consumers' stocks of newsprint in the United States resulted in a noticeable downturn in shipments of newsprint by mid-1957. The production for the year, however, was only 1 percent lower than the previous twelve months. This reduced demand in the United States adversely affected the entire Canadian pulp and paper industry. Output of wood pulp in 1957 was down by 3 percent, and the 1957 newsprint production represented only 94.7 percent of rated capacity for the year, marking the first time since 1946 that total production was less than 100 percent of capacity.

• Forest policy in Canada in the last few years has been influenced to a marked degree by a series of Royal Commissions inquiring into the present status and future prospects for Canadian forestry and by increased implementation of the provisions of the Canada Forestry Act.

In British Columbia, the second Royal Commission on Forestry in 10 years examined all aspects of forestry in the light of developments during the last 10-year period, and inquired into the extent, nature and value of the forest resources. As a result of its recommendations, new forest management licence applications will be discouraged for 5 years and, in future, the term of these licences will be limited to 21 years, with provisions for renewal. The principle of public working circles will be continued but their name will be changed to "sustained yield units." Although a forest commission was not recommended, the sole commissioner for both Royal commissions was appointed forestry adviser to the government of the province.

In New Brunswick, a forest development commission was created to study the forest resources of that province in relation to their protection, management, utilization and development. The more important recommendations of this commission included the substitution of a system of forest rentals for the present stumpage charges; long-range planning for land use by forestry, agriculture and society at large to give stability to forest tenure and management; the setting up of a nonpolitical forest advisory council; and the development of a well-designed sampling system for enumeration of forest production on private lands.

In Newfoundland, a Royal Commission on Forestry examined the forest resources of that province and recommended that future forest policy should aim at the maximum possible development of the pulp and paper industry, and that an adequate forest protection administration be set up and a forest service established.

The Royal Commission on Canada's Prospects was appointed to report on the "probable economic development of Canada and the problems to which such development appears likely to give rise." In addition to a comprehensive report, prepared by the Commission, a series of studies was made of almost every phase of the Canadian economy. *The Outlook for the Canadian Forest Industries* outlined the historical development of the forest economy, analyzed the forest resource situation, the probable effect on future forest production of losses from fire, insects and disease, and studied the lumber, pulp and paper and allied industries and their Canadian and foreign markets. This report, which was mentioned in *Unasylva*, Volume 12, Number 3, predicted that the Canadian forest industries, as a group, will more than double in size by 1980.

CHINA: *Mesh-like windbreaks stabilize shifting sand and provide conditions for afforestation, thus offering effective protection to communication lines in the desert areas. Picture shows windbreak protected section of the Paotow-Lanchow Railway built in 1958.*

Courtesy, China Features, Peking

• Research in forestry is conducted by a number of agencies in Canada. The provincial governments administer Crown Lands within their boundaries, but only three have established forest research units carrying out research programs of a relatively local nature. Limited programs of research are conducted also by the four university forest schools and by certain of the larger pulp and paper companies. The Pulp and Paper Research Institute of Canada is jointly sponsored by the Federal Government, McGill University and the Canadian Pulp and Paper Association. Its function is to promote and engage in research relating to the pulp and paper and allied industries and to establish and supervise technical standards for these industries. Research foundations also are responsible for studies in the various fields of forestry.

In spite of the number of agencies outside the Federal Government carrying out research in forestry, a very high proportion of this work is the responsibility of two federal government departments. The Forest Biology Division, Science Service, Canada Department of Agriculture, carries out research on insects and disease affecting forest and shade trees. The Forestry Branch of the Federal Department of Northern Affairs and National Resources carries out forest research, forest products research, and research in the economics of forestry. Forest research includes investigations in silviculture and forest management, forest fire protection, and forest inventory methods. Forest products research includes studies in timber mechanics, wood preservation and chemistry, wood utilization, pathology, and plywood and timber physics. Forest economics research includes analysis of forestry statistics, studies of forest legislation at all government levels, and investigations in economic problems related to forestry.

• The Canadian International Paper Company has published a well-illustrated booklet in English and French entitled *Land Use in Canada*. This summarizes in an excellent manner the way in which a timber-using industry, aware of its dependence on the small private woodland-owner for a considerable portion of its regular supply of raw material, can help itself by helping him.

Industry, with heavy capital investments in timber-conversion plant, must be assured of a regular and perpetual supply of raw material within an economically transportable radius of the conversion-site. It has both the incentive and the financial means to carry out research into methods, tree species and equipment that produce the best results. And all that is learnt is advantageously passed on to the small owners in the neighborhood, together with the necessary technical advice, guidance and even the loan of equipment and the supply, at cost, of planting material.

The company's research center becomes a demonstration area to which farmers are invited to come and see for themselves what can be done. Staff is available to visit the farms of those who are interested or in trouble, and to advise and assist, since the interests of the industry are best served " when the farmer himself is getting the best possible return from his forest farm and we can be sure he will stay in the tree farming business — and perhaps keep more of his sons and daughters on the land than he does now. "

In many areas of Quebec where the land is poor and the light, sandy soil only able to produce thin pasture or poor crops, the initiative and guidance offered by the timber industry is changing the landscape from one of derelict, abandoned farmsteads to green, productive forest.

Denmark

• Most bigger forest districts have a certain permanent staff of workers, who are occupied in the forest all the year round in the cutting and planting season supplemented by casual laborers. The last category is engaged in agriculture during the rest of the year. Some of them are smallholders.

Almost all Danish forest workers are members of a trade union (the Danish Laborers Trade Union) which comprises all groups of unskilled laborers. Agreements have been concluded between the trade union and the forest owners' federations or in a few cases with each forest proprietor separately. The organization of the forest workers in a trade union has in the course of the last 35 years secured them a very considerable improvement in real wages. Since 1938 the current — generally 2-year — agreements have contained clauses about rise or fall in wages every six months according to the index figure, so that the workers have always received full compensation for the rising cost of living.

Under an Act of 20 May 1933, it is incumbent on every employer to keep all his employees insured against the consequences of any accident. To this was added in 1950 sickness insurance and daily allowance insurance. Through their trade union the workers are also to a certain extent insured against unemployment.

Up to about 1940 Danish forestry

could easily obtain the necessary labor. A marked change has taken place since then. It is the recruiting of young workers which has failed. Some years of training is required to learn to handle modern saws and axes so efficiently that high piece work wages can be earned, and it seems as if young people do not have sufficient patience for this. Statistical investigations from the Forest Workers' School seem to show that a person will not reach his maximum output until he has worked from 7 to 10 years in the forest. Further, a general flight from the country to the towns is noticeable. A solution to these problems may be found in the increased use of powered tools in forestry operations.

Federation of Malaya

• The Federation as a whole still has no forest policy although most of the states comprising it have subscribed to a statement of policy in general terms. Under the new constitution, forestry remains a matter, as it had been previously, on which each state is empowered to legislate, the power of the federal Parliament being confined to such forestry legislation as may be necessary to promote uniformity between two or more states. The constitution, however, does provide for the establishment of a National Land Council whose responsibilities include the formulation of national policies for land, mining, agriculture, and forestry. The council is composed of representatives of the Federal Government and of the eleven states, and will, it is hoped, provide the machinery for negotiation and decision, the lack of which has hitherto stultified all attempts to agree on a common objective.

It is not to be expected, however, that results can be achieved quickly. Self-sufficiency in timber, as the main aim of productive forestry, will probably involve a 50 percent increase in productive forest reserves from 8,000 to 12,500 square miles (20,720 to 32,375 square kilometers). Much of this can only be found in the eastern states of Pahang, Trengganu, and Kelantan which must, therefore, agree to assume responsibilities as national timber providers far beyond anything they have so far accepted. These are weighty matters whose determination may require more time, study, and negotiation between states than a new Government can spare. Moreover, in a land still covered in forest to an extent of 70 percent, it is difficult for the layman to see the need for hurry.

This situation must probably be accepted for the moment, but there is one direction in which action is essential and achievable. It has been known for many years that Malaya could not support itself indefinitely in timber if it had always to depend on virgin forests whose yields were comparable to those being exploited today. One of the major tasks of the Forest Department has therefore been to develop a method of converting the existing low-yielding natural forests to others having a yield four or five times as great. This has been successfully done, but the progress (which takes place as the original trees are exploited for timber) requires time because the growing of the new trees takes something like seventy years. There thus arises the apparent paradox that the Federation as a whole is comfortably self-sufficient now, and can be so a century hence, but may well run short of supplies for a period in the interim when the requirements of a still rapidly expanding population outstrip the growing of these new timber crops.

It has only been realised since the war that the population explosion now occurring in Asia might have this effect, and that in the Federation of Malaya an actual shortage of timber might occur. The Forest Department's belief is that a shortage will almost certainly occur, and that it will do so at the turn of the present century. Whether it will last for a relatively brief period and be of manageable proportions or become permanent is a question that will be decided by what is done in the next decade or two. One thing is clear, however: if the danger facing Malaya is that the demand for timber will outstrip the growing of the new tree crops, it follows that the most effective defence against it is to set about growing the new crops as rapidly as possible in those Forest Reserves which have already been dedicated to that purpose, without waiting for precise agreement on each state's final responsibility in the matter.

Israel

• For the last few years the Director of the forest research station at Ilanoth has received a yearly grant from Mr. William Mazer of New York to enable Israeli foresters to travel abroad to study certain aspects of forestry. The grant given to these foresters is either " full ", which finances the entire tour of study, or " partial ", which subsidises foresters abroad who want to extend their period of stay for a special study. So far, three foresters have enjoyed " full " fellowships, studying in turn plant propagation in Italy, afforestation in Southern France and Corsica, and the utilization of small size timber in England, and two additional foresters had partial assistance to study poplar cultivation in Turkey and afforestation methods in Spain.

The funds of the grants have been more than enough to cover these expenses and the Director of the forest research station has received the consent of Mr. Mazer to invite foresters from abroad to study at Ilanoth for 2 to 3 months. All expenses of the tour are paid, including local and incidental expenses, travelling to and from Israel, and travel in connection with the investigation of the particular forestry problems being pursued by the visiting forester.

So far, two foresters have been in Israel under this scheme: a member of the *Istituto di Silvicultura* in Florence, who worked on soil survey problems and whose work is about to be published by the school of forestry in Florence, and a French forester who worked on poplars. A Spanish forester is preparing to go to Israel, selected by the Director-General of Forests in Spain from a long list of applicants.

Applications for travelling fellowships may be made through national forest services to the Director, Forest Research Station, Ilanoth, Box 88, Nathanya, Israel.

Netherlands

• *Agricultural Aviation* is the new quarterly trade journal of the agricultural aviation companies in Europe, published from Boschstraat 4, The Hague.

During the last decade the use of aircraft in agriculture and forestry has increased considerably throughout the world. The airplane has appeared to be a powerful weapon in the struggle of man against food shortage, a food shortage caused by the damage done by insects, diseases and weeds, but which may also have been brought about through exhaustion of the soil when it is insufficiently fertilized.

Agricultural Aviation is designed as a forum for all those who — wherever in the world — are in some way concerned with the use of aircraft in agriculture and forestry. It aims to keep them posted on any new technical developments in this field: new types of aircraft with the application equipment going with them, agricultural chemicals and fertilizers. Its columns are open to

research workers who want to publish articles on their work with aircraft, which are intended for a highly specialized group of readers who may be expected to be interested in such articles.

New Guinea

• The postwar growth in the timber industry in Australian New Guinea has been spectacular. The annual log cut in the territory now exceeds 50 million super feet per annum (227,000 cubic meters), compared with 13 million super feet (59,000 cubic meters) in 1948-49, and it is estimated that the total value of production is more than £2,000,000 per annum. Several large sawmilling enterprises are operating, and a plywood factory and a veneer slicing factory have been established.

The quarterly bulletin of the South Pacific Commission reports that a recently-approved program for future forestry development in the territory provides for a considerable expansion in forest survey work. The objective will be the dedication of four million acres (1.6 million hectares) for forestry within ten years, and ten million acres (4 million hectares) within twenty years. At present, 400,000 acres (162,000 hectares) of forest land have been acquired.

Additional trained forestry staff is being recruited and the European and indigenous field staff augmented. As staffing permits, consideration is to be given to the manning of additional forestry stations. A forestry school is to be established at Bulolo to give training for positions in survey, silvicultural and marketing control work.

Research work will be continued on the silvicultural problems associated with hoop and Klinkii pine plantations, and emphasis will be given to the problem of natural regeneration of the main forest types of the territory.

Reforestation will be expanded, particularly in the Wau-Bulolo forests of New Guinea, in the Trans-Keravat forest of New Britain, and in the Mt. Lawas territorial forest near Port Moresby. Regeneration will be encouraged wherever appropriate.

Experimental afforestation is to be undertaken on the extensive grasslands of the Highlands to provide basic information on suitable silvicultural techniques in erosion control works and the reclamation of grassland areas.

Provision is made in the current program for investigations to continue into the utilization of the many untried tree species available in the forests of the territory. Close liaison in this work will be maintained with the Division of Forest Products of the Commonwealth Scientific and Industrial Research Organization.

The task will be continued of building up a botanical collection of all the varied forest plants in the territory as a basic service to the Department of Forests and private sawmillers.

New Zealand

• With the steady expansion and continued prosperity of pastoral farming in New Zealand, the pressure of demands for the release of forest land for agricultural use has not abated. The land-use committees (composed of experts in the fields of agriculture, forestry, soil conservation and land development) appointed to advise the Government on the final disposal of land, the use of which is disputed, have thus been fully occupied, and many large areas will have to wait some years for decisions. However, the trend towards piecemeal release of fertile lands and the acquisition of land needing permanent protection has progressed well, and the Forest Service has now acquired control over a very large proportion of all coastal sand dunes that require fixation.

Establishment of new production-forest resources, both privately- and publicly-owned, continued steadily between 1956 and 1958. But because of conditions affecting land use described above this has been very largely restricted to land already held as forest land.

Acquisition of new areas for production forestry is hindered by the very high cost of land in those regions where a timber shortage makes afforestation particularly desirable. For this reason certain demands for government action in parts of Auckland, Marlborough, Canterbury and Otago cannot be met; and the Forest Service has encouraged farm forestry as an alternative source of timber supply.

Public awareness of the importance of high-country catchments is growing, and the problems caused by fire and grazing with consequent erosion, shingle deposition and lowland flooding are being more intensively tackled.

The first phase of the National Forest Survey, the assessment of the indigenous timber resources, has been completed, and the volumetric results for all forest types according to species, tenure and accessibility published in May 1957. A national survey of exotic resources has begun, and also a survey of protection forests, by catchments. The latter was given priority because of the critical state of many high-country catchments revealed by the first phase of the survey. A range and experiment station has been set up in the South Island to conduct the survey, and undertake research in animal/vegetational relationships and in range management techniques under the general direction of the Forest Research Institute.

• It is officially reported to FAO that the timber industry in New Zealand, which has been built up considerably since the end of the war, has now reached a point where its capacity of approximately 650 million board feet (1.5 million cubic meters) is sufficient both for home consumption and export.

New Zealand is now by far the world's largest producer per head of population of preservatized timber for building purposes. Species of timber available, traditional methods of house construction and developments in preservation techniques are the main reasons for this. The increased use of exotic softwoods which are just as liable to decay and no less susceptible to insect attack than indigenous timbers, and the difficulty of ensuring throughout the life of a building that moisture cannot enter any part, demand the wide use of preservatized timber. Much controversy has naturally arisen regarding the effectiveness of various types of treatment and the extent to which treated timber should be used in a building.

In September 1955, the Government, in order to resolve these questions, set up a Timber Preservation Authority under the Timber Preservation Regulations, 1955. The principal function of the Authority is to secure and maintain a high standard of timber preservation. All treatments carried out must be in accordance with the requirements of the Authority, which has established an inspecting organization under the New Zealand Forest Service. The Authority has adjudicated on and approved a number of specifics and methods which were previously the subject of controversy. Notably the application of boron compounds by diffusion has been accepted for all timber requiring treatment for light building construction other than those for use on contact with the ground. The regulations under which the authority functions permit it to prescribe that no preservative-treated timber can be marketed unless the treatment and the marking of the timber agrees with the Authority's requirements. Progress in preservation practice and use of treated timber will now be quickened. Latest figures show that 17 percent of total timber production was treated by diffusion and pressure impregnation in 1958.

Treatment of exotic forest thinnings is continuing to fall short of demand, although treatment facilities are steadily being increased. This treatment enables this otherwise low utility produce to be used for farm and engineering requirements where durability in the ground is important.

The pulp and paper industry now comprises three integrated units producing sawn timber, chemical and mechanical pulp, paper and paper board. There are two plants producing paper and tissues from purchased raw materials, imported and home produced.

Plans for further expansion are in different stages of preparation and it is expected that newsprint and kraft paper production will have doubled by 1965. Present production figures are 90,000 tons of mechanical pulp; 120,000 tons of chemical pulp; 65,000 tons of newsprint; 38,000 tons of other paper; 28,000 tons of paper board; and 21,000 tons of fibreboard.

Construction of the first wood particle board plant has been completed and consideration is being given to establishing a second one.

Import restrictions on steel and imported timbers have given added impetus to the use of radiata pine in glued laminates for constructional purposes. Already several buildings employing glued laminates have been erected and great interest is being shown by engineers and architects.

The trend towards the increasing use of the moderately dense indigenous hardwoods in light building construction has continued. Grading rules for tawa (*Beilschmiedia tawa*) following the pattern of rules in use for the principal indigenous softwoods used in building have been approved by the New Zealand Standards Institute Committee concerned with revision and extension of grading rules. The same committee is now considering rules for the three main indigenous beech timbers along similar lines. Tawa has its main uses in building in flooring, interior finish and furniture, but wider use of lower grades for framing is now envisaged. End-matching has been introduced for flooring of this timber and also for red beech (*Nothofagus fusca*). Preservative treatment of beech mining-timbers has become an established industry using diffusion methods of impregnation.

Nyasaland

• The Chief Conservator of Forests writes as follows:

"I feel that I should draw your attention to an apparent inaccuracy in respect of this country in the otherwise most useful and interesting article "Pines for Tropical Areas" in *Unasylva*, Vol. 12, No. 3 of 1958.

On page 130 it is stated as follows: "[*Nyasaland. P. cembroides, P. taeda, P. pseudostrobus, P. canariensis, P. montezumae, P. elliottii, P. patula*, have been successfully established at 3,000 to 7,500 feet (900 to 2,250 meters) with 40 to 110 inches (1,000 to 2,800 millimeters) rainfall and are very promising, while *P. longifolia* has been established at 2,500 to 3,500 feet (750 to 1,000 meters) with 30 inches (750 millimeters) rainfall and is promising. Indifferent results have been obtained with *P. caribaea* and *P. leiophylla*."

One reference for Nyasaland is given at the end of the article, namely: Willan R.G.M. and McQueen D.R. *Exotic Forest Trees in Nyasaland*. Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957. As the passage quoted above from the article conflicts entirely with this paper, of which I was one of the authors, I feel that I should point out the following facts:

1. *Pinus cembroides* has never been introduced into Nyasaland, and it is not listed in the general list of exotic trees at present growing in Nyasaland given at the end of the paper. As far as I am aware *P. cembroides* is not a synonym for any other species which is mentioned in the list.
2. In the paper both *P. patula* and *P. elliottii* are given amongst the five exotic species grown on a *commercial scale* in Nyasaland. In actual fact the plantations now run to many thousands of acres and timber is being milled and sold, so it would appear to be a rather peculiar understatement to say merely that they have been successfully established and are very promising.
3. *P. roxburghii* (syn. *P. longifolia*) is included in the list of other exotic species which are growing successfully on a small scale pending assessment of their future potentials, together with *P. taeda*, *P. pseudostrobus*, *P. montezumae* and *P. canariensis*.
4. *P. caribaea* and *P. halepensis* are included in the general list of exotic trees growing in Nyasaland. There is no statement to the effect that 'indifferent results' have been obtained with them, and in actual fact the growth of *P. caribaea* is exceptionally good, while *P. halepensis* grows very successfully, though on account of its poor form as compared with certain other species, it is considered unlikely that it will be grown on a commercial scale here. I might add that the growth of the majority of the trees in the general list is entirely satisfactory, but as they are not grown on what might be termed a 'commercial scale', they are not given separate treatment in this paper.

If at any time contributors to *Unasylva* require any information on forestry in Nyasaland, I shall be only too pleased to assist them with up-to-date information."

Paraguay

• Writing in the *United Nations Review*, a former Resident Representative of the United Nations Technical Assistance Board describes how he took a special interest in the jungle area which borders on Brazil and Argentina, not only because it is the source of logs and lumber and quebracho extract, which constitute most of Paraguay's exports, but because it seems destined to play a very important part in the economic future of Paraguay.

The Paraguayan frontier with Argentina and Brazil is marked here by the River Paraná and a great program is now under way for the planning of land settlements, roads, ports and new villages, in which an interesting part is being played by United Nations and FAO experts.

The Paraná river is one of the great waterways of the world. It is as long as the Mississippi and has an annual flow no less than five times that of the Nile. A highway, which will link the capital with the neighboring countries, will be carried across this river over an international bridge about 500 yards long and 270 yards high, an arch which will be the highest concrete structure of its kind in the world and which will join the new highway to a Brazilian road running to Paranagua on the Atlantic.

This will be a step of the greatest importance for Paraguay's economic development, as it will offer the country for the first time in 400 years direct access to a free port on the Atlantic coast. Paraguay has always suffered from the disadvantages of being a landlocked country, whose access to the sea depends on its rivers.

Poland

• The sale of timber and of wood products is in the hands of the Central Management of Sales, which disposes of 17 regional offices, constituting a

link between producers of wood products and consumers. In view of the timber deficit, especially of certain assortments, sale is based on central allocations fixed for each of the industries.

An official report to FAO gives the annual consumption of timber per caput in Poland as 0.53 cubic meters. In terms of roundwood, timber consumption breaks down as follows:

	Percent
Housing, industrial and rural construction	40
Mining (pitprops-80 percent)	18
Transport, telecommunications, power	8
Packaging	4
Furniture industry	5
Cellulose, paper production	11
Fuelwood	7.5
Other purposes	6.5

The relatively high consumption of timber is due to the considerable needs of the country resulting from war damages, and to the underdevelopment of industries producing building materials and materials substituting timber. If it is to develop its economic life, Poland must exploit more timber than the annual allowable cut of around 12.5 million cubic meters. At present the country is taking from its forests around 16 million cubic meters of timber. However, recent efforts made towards substituting timber by other materials indicate that cuttings should begin to drop within the next few years, until reaching the theoretical limit.

Rhodesia

• The forest clearance operations carried out in connection with the Kariba Gorge scheme in the Federation of Rhodesia and Nyasaland may prove to be the greatest ever undertaken. The scheme, which will cost about U.S.$15 million, involves the damming of the Zambesi river some 300 miles below the Victoria Falls. The Kariba dam is the largest in the world and behind it an artificial lake will within four years cover about 2,000 square miles (5,000 square kilometers).

In order that this vast new lake covering what was previously forest and bush country, may supply fish as well as, indirectly, hydro-electric power, large zones in the area of the Zambesi valley now being flooded are cleared of brush and trees and then leveled to constitute future fishery beds. One zone cleared 15 miles from the dam covered 37,000 acres (15,000 hectares) and another 45 miles upstream an area of 62,000 acres (25,000 hectares) south of the Zambesi, along the Sengwe and Bunni valleys.

The larger trees in the clearance zones are axe-felled including numbers of giant baobab (*Adansonia digitata*) trees, many of them 50 feet (15 meters) in circumference. The smaller trees are pushed over by means of two 320 h.p. Caterpillar tractors pulling a 15-ton chain whilst a third tractor pushes the chain against the tree. In one zone of 8,000 acres, 1,000 baobab trees were felled and an estimated 64 million cubic feet (1.8 million cubic meters) of wood burned. The trees in the areas between the fishing beds are not being felled, but channels are being driven through them and lined with marker buoys. Through these cleared channels the fishing fleets will eventually be able to sail from one fish bed to another.

• The *Conservation of Natural Resources*,[1] recently published, is intended to serve as a practical conservation guide. The sacrifice of technical detail to reach this objective has been offset by the coverage given to the conservation field in its widest aspects. The book, which forms a valuable addition to the literature in the field of applied conservation, is based on experience in the south, east and central parts of Africa but Africa's problems in these areas are not different from those found in the dry tropical and subtropical sections of Australia, India, Pakistan, Iran, the Near East and Far East, and in the Americas.

Land-use planning in its broadest sense is given recognition throughout the book. The need for the mapping and classification of land as to capability and use and the integration of this information into workable local and regional plans is stressed: plans, based on land capabilities and water resources, should include provision for domesticated crops and pastures, tree woodlots and shelterbelts, timber producing and protection forests, managed range grazing, wildlife maintenance and fish culture. There are striking examples among the illustrations of "before and after" pictures, showing the results of applied soil conservation work in Africa.

Surinam

• The forests of commercial importance in Surinam may be distinguished broadly as two types: swamp forests in the young and old coastal plains and dryland forests in the interior.

Apart from relatively small forest tracts on old abandoned plantations, all forests are owned by the state and administered by the Forest Service, which was re-established in 1947. Shifting cultivation in this area is tolerated in the environs of local settlements.

The whole logging and timber industry is in the hands of private individuals. On government-owned land, concessions or timber-cutting rights have been granted on an area of about 1.25 million hectares by the Ministry of Finance, upon the recommendation of the Bureau of Lands and the Forest Service. Extraction is done partly by manpower, partly by wheel or small crawler tractors. The logging industry is almost entirely established on the river banks. It is prohibited to cut trees with a diameter less than 30 centimeters d.b.h.

Logs are usually transported by water to Paramaribo, the capital of the country, where 16 sawmills, a plywood factory, factories for crates, strip and parquet flooring, precut houses and precut matches, shops for joinery, molding and furniture are located. The building industry is attaching more and more value to wood preservation and since the end of 1956 a small impregnation plant is operating.

The construction of a particle board factory handling about 50,000 cubic meters raw material — partly wastage of the plywood factory — is nearing completion, according to an official report to FAO.

Though annual cuttings are only about 130,000 cubic meters, the timber industry yields roughly 10 percent of Surinam's annual export values against 80 percent for exported bauxite, the prime natural resource of the country.

Thailand

• In January 1959, the government issued an announcement that drastic amendments would be made to the forest law in Thailand with a view to removing existing loopholes and to putting a stop to present wastage of national forest wealth through illicit fellings and irregular practices. In the meantime, until these amendments could be given effect, orders had been issued to provincial governors to freeze all working of teak and *yang* forests for 120 days with immediate effect — excluding timber on which royalty or the due price has been already paid to the competent authorities.

These new legislative steps accord with the recommendations expressed by a FAO technical assistance officer, F. Loetsch, who has carried out two assignments in Thailand, in 1955 and 1956-57, to inventory and recommend

[1] *The Conservation of Natural Resources* - R.C. Haw, 255 pp. illus., Faber and Faber Ltd. London, 1959.

a program of management and exploitation for the northern teak-bearing forests of Thailand.

By 1957, shifting cultivation and illicit fellings appeared to have reduced the former area of teak-bearing mixed deciduous forest by more than half and only one third of the mountainous forests remained, the rest had been destroyed. The inventory revealed that, unless legal measures were taken to prevent illicit fellings and to control shifting cultivation in teak-bearing areas, the collapse of the Thai teak industry must be faced.

The Minister of Agriculture in the new Government is a former member of the Royal Forest Department. During 1951-52 he traveled abroad to study forest management on an FAO Fellowship.

Union of South Africa

• Of the larger nature reserves and national parks, the Kruger National Park of 5,000,000 acres (2,000,000 hectares), is approximately three quarters the size of Belgium or half the size of Holland.

There are fourteen rest camps scattered throughout the park at convenient distances from one another, which provide accommodation for 3,000 visitors per night, and this limit is strictly controlled by the administrators. The Kruger National Park has shown the way in South Africa as to what can be done with so-called nature tourism.

The Kalahari Gemsbok National Park (about half the size of the Kruger Park) lies on the extreme western boundary of the Union of South Africa and South West Africa. This is a semidesert or a thirst land where endless stretches of sand dunes follow one another. They are sparsely vegetated with trees and shrubs which are adapted to the dry and arid conditions. Notable fauna include the gemsbok (*Oryx gazella*), springbok (*Antidorcan marsupialis*), red hartebeest (*Alcelaphus caamus*), and blue wildebeest (*Gorgon taurinus*). Two rest camps have been built in this area and it is encouraging to see how many thousands of visitors go to the park, which is completely different from the Kruger Park in its appearance, its plants and its animals.

Another national park is the Mountain Zebra National Park in the Karroo, the dry central part of the Union of South Africa, with mountains and escarpments overgrown with plants and trees which can survive under such conditions. This is the only place where the mountain zebra actually occurs. It is wholly protected, as are also other animals which are common in this area.

The Addo Elephant National Park is another well-known place with a very characteristic flora, and where the Addo elephants and other indigenous animals are protected. It is located not far from Port Elizabeth, one of the larger harbor cities, and hundreds of visitors come to the park daily.

Apart from these national parks there are numerous provincial nature reserves, for instance, the Hluhluwe Nature Reserve in Natal where an extremely beautiful subtropical flora is protected and where, in particular, rhinoceros (*Ceratotherium simum*) are guarded.

The Department of Forestry has set aside more than 100 localities in the Union as so-called indigenous forest reserves, such as the Knysna Forest in the Cape Province, Nkandhla in Natal, Tsitzikama in the Cape, Sabi in the Transvaal. These forest reserves are strictly protected.

United States of America

• According to the United States Fish and Wildlife Service, anticoagulant compounds such as " warfarin " give excellent control for rats and mice when properly used. They reduce or prevent clotting of the blood when consumed over a period of several days producing death to animals by causing internal bleeding. Such a compound will not give effective control when applied in a single dose. It must be eaten on five or more successive days which should occur within a period of 10 to 14 days. From 4 oz. to one 1 lb. of bait is suggested as the amount to be placed in each location. For mice, use smaller quantities in more locations.

It is important that ample quantities of bait be available at all times during the baiting program. The bait may be exposed in shallow open trays or self-feeder boxes placed in rooms or dry places where rats and mice feed or travel. Stations should be inspected and bait added daily if needed during the first few days of treatment and at periodic intervals thereafter.

Anticoagulant concentrate	1 lb. (0.45 kg)
Yellow corn meal	18 lb. (8.5 kg)
Granulated sugar	1 lb. (0.45 kg)

There is as yet no indication that the animals develop either an aversion or tolerance after repeated feeding. Anticoagulants would probably kill any warm-blooded animal if consumed in sufficient quantity over a prolonged period of time. However, the poison concentration in baits recommended for rat and mouse control is so low there appears to be a minimum of danger to other animals. Baits should not be exposed in locations where they may be consumed by children, irresponsible persons, or domestic animals. In case of accidental ingestion, vomiting should be induced at once. In serious cases, treatment by a physician should include transfusion with whole blood and intravenous and oral administration of Vitamin K or K_1 preparations according to instructions.

Some anticoagulants are available in a water-soluble form. The contents of each packet or can are mixed with one quart of water and usually exposed to rats and mice in baby chick founts. This liquid form is especially desirable where rats and mice fail to eat dry baits.

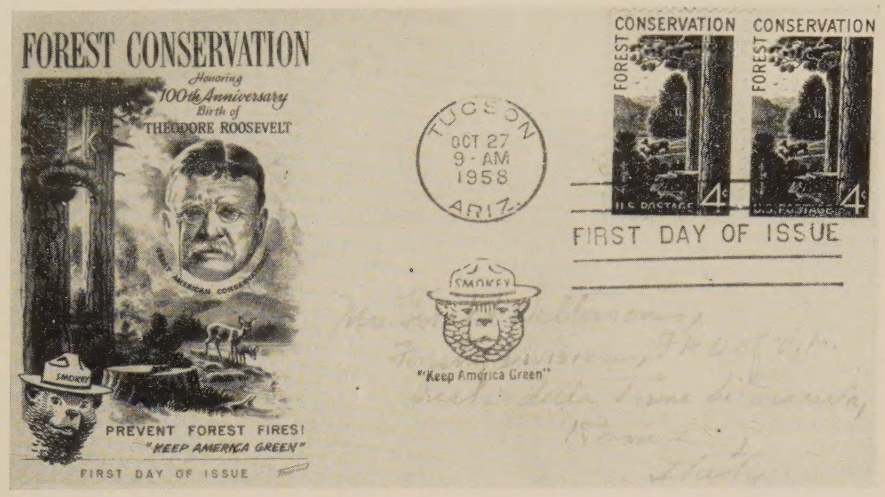
• The protected area of forested lands and non-forested watershed lands in the United States is now 91 percent of the total in need of protection. The protected area of state and private forest lands was increased by 5 million acres (2 million hectares) during 1955-57.

Further progress has been made in reducing losses caused by destructive insects and diseases by improved detection and evaluation of outbreaks, increased attention to preventive measures, and by prompt control action. During the three-year period, 1955-57, insecticides were applied by airplane to over 5 million acres of forest land to control outbreaks of defoliating insects, and by ground equipment to over 1 million trees in a number of projects to supress outbreaks of bark beetles. Additionally, some 2.2 billion board feet (10 million cubic meters) of insect-infested and susceptible timber was logged as an adjunct to control.

Control of the blister rust disease was extended, and this disease is now under control in 80 percent of the 23 million acres of white pine control area in the United States. Federal and state governments co-operated in the control of the oak wilt; there were no significant increases in the external boundaries of areas in the 18 states infected.

The United States Forest Service in 1956 consolidated responsibility for control of both forest insects and diseases in a new Division of Forest Pest Control.

• A forest fire research laboratory, near Macon, Georgia, is scheduled to begin operating early in 1959. It will play a big role in helping the



UNITED STATES: *A 4-cent Forest Conservation commemorative stamp went on sale in October 1958, at Tucson, Arizona, at the annual meeting of the American Forestry Association. It is printed in three colors — yellow, brown and green, and features the major aspects of forest conservation: the harvesting of mature timber under scientific forest management and new growth of young trees, home and shelter for wildlife and birds, and protected watershed.*

The first specifically forest conservation stamp to be issued in the United States commemorates the 100th anniversary of the birth of Theodore Roosevelt, one of the earliest forest conservationists in the country. It also salutes the many private and public agencies which have played a large part in the progress made in the protection and wise use of the nation's natural resources.

South protect its valuable woodlands from fire.

The laboratory is a joint undertaking between the U.S. Forest Service and the State of Georgia. Its purpose is to apply modern science and technology to the job of cutting down the millions of dollars in loss which Southern forests suffer annually from wildfire. Fire scientists there will seek to learn more about the natural laws that affect fire in the woods, and why fire responds in certain ways to weather and natural fuels.

From such knowledge the scientists hope to come up with new and more efficient ways to control forest fires. This part of the work will include special studies in convection, heat transfer, and fire physics.

• *Resource Training for Business, Industry, Government* (Nature Resources Study Committee, 159 pp. The Conservation Foundation, New York 1958) is, as its title indicates, pointedly directed at the lawyers, economists, planners, bankers, business executives and legislators, who are in a position to put to fruitful use the knowledge of the specialists who function as resource technologists. One of the book's objectives is to arouse in such influential men an understanding of the role of, and growing need for, conservation of natural resources in a world where industry often is developed at their expense. These are the men who must be responsible for the application of resource conservation within the framework of such industrial expansion. They are the ones who are in a position to employ the university graduate with training in this field.

At the same time the book contains valuable information on how, at university level, such "generalists" in conservation can most effectively be trained to join the ranks of those whose skills and judgement may be applied practically in resource-use problems.

• *Variation in Tracheid Length and Wood Density in Geographic Races of Scotch Pine* (R. M. Echols, Yale University School of Forestry Bulletin 64, New Haven, 52 pp. 1958, $1.50) is an important contribution to an understanding of the importance of geographic source of seeds, and should help tree planters in selecting provenances to meet specific needs in terms of wood qualities.

Using samples from 17-year-old trees of 15 geographic races of Scots Pine planted in New Hampshire, U.S.A., as part of the 1938 provenance tests organized by the International Union of Forest Research Organizations, the author measured length of tracheids and wood density. These measurements revealed very highly significant variations in both factors in different geographic races.

The trees from provenances with greater day-length in summer appeared genetically adapted to longer periods of light, and were kept from making more rapid growth by the shorter light periods in the more southern latitude.

The study suggests that if wood of high density is desired rather than rapid rate of growth, the more northern provenances should be used. Relatively fast growth and lower density may be obtained from races from Latvia - Poland - Romania sources. A compromise between growth rate and density may be found in southern Sweden and Italian sources.

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